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WHITE RIVER SHALE OIL CORPORATION

SUITE 500 PRUDENTIAL BUILDING, 115 SOUTH MAIN STREET
SALT LAKE CITY, UTAH 84111
(801) 363-1170

JIM

May 24, 1982

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DIVISION OF
OIL, GAS & MINING

Mr. James Smith
Utah Division of Oil, Gas and Mining
State Office Building, Room 4241
1588 West North Temple
Salt Lake City, UT 84114

Subject: White River Shale Project
Topsoil Management Plan for Mining Activities

Dear Mr. Smith:

During UDOGM's visit to the White River Shale Project (WRSP) site on May 5, 1982, topsoil management was briefly discussed. The following information is provided to more clearly delineate our approach to topsoil management as described in our Phase I Mining Permit Application.

The primary purpose of topsoil recovery from areas disturbed during construction of the Phase I mine and ancillary facilities is to stockpile suitable growth media for reclamation of construction and operations disturbed areas and the processed shale disposal area. To this end we plan to recover all topsoil-like material in the areas to be disturbed as indicated on Figure 1-3 of our Phase I Mining Permit Application. As you are aware, there is no true topsoil in the areas to be disturbed and, consequently, much of the topsoil-like materials recovered will be less than ideal growth medium.

Additional topsoil-like material will be recovered from the retorting and upgrading process area scheduled for construction in 1986 and the processed shale disposal area beginning in 1988. A significant volume of the recovered topsoil material may be stored for up to seven years which is a relatively long period of time during which soil properties might change due to weathering and bacterial action. Therefore, it is planned to conduct topsoil analyses prior to its reuse. This will allow a determination to be made at that time regarding the desirability of amending the stockpiled material for reclamation usage. Research is being conducted for the WRSP to determine the effects of long-term stockpiling of topsoil materials. The results of this research will guide our stockpile designs and rejuvenation plans.

Soil associations occurring at the project site are described in Paragraph 1.3.5.1 of our Mining Permit Application. This information was developed during the 1976 WRSP baseline survey by VTN Consolidated, Inc. Currently we are collecting additional soils information at the site as part of a comprehensive geotechnical investigation. This work is being done by Woodward-Clyde, Inc. under subcontract to our engineering and construction contractor, The Ralph M. Parsons Company. Correlation of project site soil data developed by VTN, Woodward-Clyde, and others with detailed soils characterization and mapping of the Phase I disturbed areas will be sufficient to identify topsoil resources for recovery.

VTN mapped soils occurring on Federal Oil Shale Tracts Ua and Ub are as shown on Figure 1-13 of our permit application. Nine different soil types were identified on the site. Each of these soil types is described in Section V of the WRSP First Year Environmental Baseline Report (see Exhibit A) and includes information on soil texture, thickness, underlying parent material, occurrence, elevation, and covering vegetation. A representative pedon for each soil type was analyzed and described. Analyses included particle size distribution, organic carbon, electrical conductivity, $CaCO_3$, Mg, Na, K, moisture tension, and percent moisture at saturation.

The current plant site geotechnical investigation includes a number of borings and test pits described in Paragraph 1.2.4.2 of our Mining Permit Application. Analyses of soils recovered from these sources includes natural moisture content, particle size, apparent specific gravity, and soil liquid limit. Additionally, a topsoil isopach map will be prepared and available in about two or three weeks to facilitate material recovery. This map will be based on existing geotechnical information and verification through surface observation and measurements of topsoil material depth.

The topsoil map will serve as a guide during topsoil material stripping operations. Based on information provided by Woodward-Clyde, Parsons will identify topsoil material recovery techniques appropriate to the mapped resources. Parsons will manage the earthwork sub-contract and through an experienced soils engineer who will be on site provide technical direction during topsoil material recovery operations. The soils engineer will correlate the topsoil map to the areas to be worked by flagging resource areas or other means, spot check recovery operations to verify that all practicable topsoil material is recovered (as required by the earthwork subcontract specifications), and attempt to assure that topsoil material is properly segregated and stockpiled separate from unsuitable subsoils or engineering fill material.

Topsoil materials removed from designated areas will be stockpiled at the locations indicated on Figure 1-3 of the Mining Permit Application. Both the stockpile areas and access to these areas will be within the Phase I development area to avoid unnecessary impacts to surrounding areas. The stockpiles will be established and protected as described in Paragraph 1.3.5.3 of the permit application. The area for the stockpile will be graded to provide a stable base for the pile and to provide diversion ditches or earthen berms to control run-off from surrounding areas. The primary procedure to control wind erosion during development of the pile will be the use of water, as necessary. Other methods such as plastic covering or mulching may be used if severe erosion conditions are evident or anticipated. Once a portion of the pile has been developed to its final configuration (maximum depth of 15 feet) it will be seeded as described in Paragraph 1.3.5.3 of our Mining Permit Application. If severe erosion conditions are apparent or anticipated prior to establishment of a vegetative cover, a biodegradable soil stabilizer may be used. The seeded stockpiles will be irrigated as necessary to establish and maintain the vegetative cover.

The topsoil material storage area located in the vicinity of the run-off retention dam will be used to collect topsoil material stripped from the dam site and associated access roads and work areas. Topsoil material stored at this location will be used to rehabilitate the dam work areas. Excess topsoil material will be transported to the stockpile located in the vicinity of the mine service building. This storage area will also accommodate topsoil material recovered from the raw shale stockpile, decline/shaft complex, mine service building and related access roads and work areas. With minor exceptions (e.g. vegetation of permanent regraded slopes), the topsoil material stockpiled at this location will be stored for a relatively long period until the Phase I mining facilities are completed (estimated 1985-1987) and processed shale disposal area reclamation is initiated (estimated 1989). As mentioned previously, the topsoil material stockpiles will be analyzed prior to reuse to determine their suitability for reclaiming the processed shale disposal area.

White River Shale Oil Corporation believes that the above described topsoil management approach is comprehensive and provides assurance that our topsoil recovery and reuse plans are realistic and will be achieved. Thus, WRSOC requests that UDOGM provide interim approval to allow specific field work to proceed prior to formal approval of our Phase I Mining Permit Application, as discussed in our letter of April 7, 1982.

Our planned construction activities during the interim approval phase (until September 1, 1982) will disturb approximately 56 acres on-tract. Exhibit B lists those areas which will be developed during this phase of construction. Exhibits C and D (Figures 1-2 and 1-3, respectively, in the Mining Permit Application) show the disturbed areas during the interim phase. All topsoil material recovered for long-term storage during this interim phase will be stored in the shaded stockpile area shown in Exhibit D.

Exhibit C shows two areas which will be disturbed prior to September, 1982, in addition to those shown in Exhibit D. These areas consist of the following: a small section of the bachelor construction camp area and a service road which will provide access to our production water well area. Work at both of these areas is not expected to occur until August and, hence, the grading plan details have not yet been developed. However, a more detailed map for both of these areas will be supplied in the near future for your approval. In addition, a copy of the topsoil isopach map will be submitted to UDOGM prior to the start of earthwork activities.

If you have any further questions concerning this matter, please call.

Sincerely,

Ralph A. DeLeonardis

Ralph A. DeLeonardis
Permits Coordinator

RAD/fb

Attachments

cc: P. A. Rutledge (w/attachments)

EXHIBIT A

V. SOILS AND GEOLOGY

A. SOILS

1. OBJECTIVES

Soils on the tracts were studied to define and document soil conditions prior to development. These data are essential as a basis for planning and designing the mining and processing facilities.

2. METHODOLOGY

The soils were surveyed according to the standard procedures of the Soil Conservation Service (SCS) and the Utah Agricultural Experiment Station, Department of Soils and Biometeorology. These procedures are given in recent soil survey reports (U. S. Dept. of Agriculture 1973) and will not be included in this report.

Prior to the study, a reconnaissance was conducted by stereoscopic study of aerial photographs and by on-site observations. Geologic maps of the area were studied to determine general relationships of parent materials to the soil types. The vegetation and relief were studied to determine their relationships to the soils.

The detailed survey was conducted by first selecting a map scale and aerial photographs. The photos were studied by stereoscope to determine the direction of traverses, which are made at right angles to the linear trends of the landscape. Selected areas were then excavated to expose the soil layers, or horizons, which generally extend from the surface down into the parent material. The sequences of these natural layers are described in detail according to methods and nomenclature of the Soil Conservation Service (U. S. Dept. of Agriculture, 1951).

While the survey was in progress, soil samples were collected at selected locations from each horizon for processing at the soil laboratory at Utah State University (USU). Comparisons of field data and analytical data obtained from the laboratory were the basis for naming the soil types.

3. SUMMARY OF RESULTS

a. Soil Survey

The soils were mapped according to their location on the tracts (Figure V-1). Each map unit represents one soil type or complexes of two or more soils so intermingled or small in extent that they cannot be shown separately. Each soil complex contains at least 75 percent of the two or more dominant soils, and the distribution and relative proportions are about the same in all units. The name of a soil complex consists of the names of the dominant soils joined by a hyphen. Because rock outcrop and bare rock surfaces are extensive in the area, some of the map units are complexes of soils and rock outcrop.

Nine different soils were identified on the site--A, As, B, Bs, Ds, E, F, N, W. The description of each one includes information on soil texture, thickness, underlying parent material, occurrence, elevation, vegetation, precipitation and temperature. A representative pedon (a block of soil considered typical of the soil type being discussed) is described for each horizon. Following the description of the representative pedon is information on soil use and hydrologic characteristics. The map units in which the particular soil dominates are described. The occurrence of the map unit, the percentage of the unit occupied by the dominant soil, the other important soils in the complex, and the slope angles of the unit are stated.

A Soils: The A soils consist of shallow channery loams. The soil depth ranges from about 30 cm to 50 cm (12 in. to 20 in.) and overlies bedrock of the Green River Formation. They occur in upland settings on 5 to 40 percent north-facing and east-facing slopes. A soils occur in association with B soils. B soils generally occur on south-facing and west-facing slopes at elevations ranging from about 1,590 m to 1,710 m (5,200 ft to 5,600 ft). The vegetation established on the A soils consists mainly of sagebrush and shadscale with scattered Indian ricegrass and bluebunch wheatgrass.

Average annual precipitation ranges from about 15 cm to 20 cm (6 in. to 8 in.), and the mean annual soil temperature ranges from about 4°C to 7°C (40°F to 45°F).

A representative pedon on a steep north-facing slope (about 30 percent slope) on the west side of Evacuation Creek Canyon, about 460 m (1,500 ft) south and about 180 m (600

LEGEND

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TO 60 PE

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5 TO 40

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SANDY LO

· SANDY LO

· DEEP LOA

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SLOPES

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SOIL, 5

· DEEP SILTY

UTAH

PHOT

SOILS MAP

OIL SHALE TRACTS Ua, Ub AND CORRIDOR

NOVEMBER 1975

FIGURE V-1

ft) east of the North quarter corner of Section 13, T10S, R24E follows:

A_1 0 cm to 6 cm (0 in. to 2.4 in.)--pale brown (10YR6/3) channery loam; brown (10YR4/3) when moist; weak, fine, platy structure; slightly hard, friable, slightly sticky, and slightly plastic; moderately calcareous; moderately alkaline (pH 8.0); clear, smooth boundary.

C_1ca 6 cm to 20 cm (2.4 in. to 7.9 in.)--pale brown (10YR6/3) very channery loam; massive; slightly hard, friable, slightly sticky, and slightly plastic; plentiful fine roots; strongly calcareous; moderately alkaline (pH 8.3).

C_2ca 20 cm to 45 cm (7.9 in. to 17.7 in.)--very pale brown (10YR7/3), very flaggy loam; pale brown (10YR6/3) when moist; massive; slightly hard, friable, slightly sticky, and slightly plastic; abundant, very fine roots; strongly calcareous; strongly alkaline (pH 8.7); bedrock at 45 cm (18 in).

R 45 cm (17.7 in.)--bedrock of the Green River Formation.

The content of coarse fragments, channers, and flagstone is high throughout with numerous channers and flagstones on the surface. Estimates of the coarse fragment content is as follows: 0 cm to 6 cm (0 in. to 2.4 in.), 25 percent; 6 cm to 20 cm (2.4 in. to 7.9 in.), 50 percent; and 20 cm to 45 cm (7.9 in. to 17.7 in.), 80 percent, mainly flagstones. Lime coats the undersides of coarse fragments, and there are many hard lime pendants.

Vegetation supported by these soils is used for wildlife habitat and winter sheep grazing. Permeability is moderate, and runoff is medium to low. The hazard of erosion is moderate. This soil will hold from 2.5 cm to 5 cm (1.0 in. to 2.0 in.) of available water.

A Channery Loam, 10 to 20 percent slopes (A1): This mapping unit occurs on broad, convex ridge tops in a few small areas in the eastern part of the survey area and is associated mainly with areas of AC-BD complex. About 75 to 85 percent of the unit is A channery loam on 10 to 20 percent slopes. Inclusions are mainly A channery loam on 20 to 40 percent north-facing slopes and small areas of B channery loam on 20 to 40 percent slopes.

A Channery Loam, 3 to 8 percent slopes (A2) : This mapping unit occurs on nearly level to gently undulating mesa tops in the western part of the area, mainly in Southam Canyon, in isolated areas completely surrounded by very steep escarpments of Rockland - BsE complex. Bodies are irregular, generally long, and comparatively narrow. Vegetation is shadscale, black sage, rabbitbrush, needle grass, and curly grass. About 75 to 80 percent of this mapping unit is A channery loam on 3 to 8 percent slopes. Inclusions consist of B channery loam, B flaggy loam, and A flaggy loam. The very shallow B soils occur near the outer edges of the mesa tops.

AC-BD Complex, 10 to 40 percent slopes (A3): This mapping unit is moderately extensive. It occurs in the eastern part of the area in upland settings between Evacuation Creek and Hells Hole Canyon and is generally associated with the AD-BD complex, which is very similar except for slope gradient.

About 45 to 55 percent of the complex is A channery loam on 10 to 20 percent slopes. It occurs on broad convex ridges and gentle north-facing slopes; 25 to 30 percent is B channery loam on 20 to 40 percent steep south-facing slopes. Included with this unit are small areas of A channery loam on 20 to 40 percent slopes (AD) and D channery loam on 5 to 10 percent slopes in small drainageways.

AD-BD Complex, 20 to 40 percent slopes (A4): This mapping unit occurs extensively in the eastern part of the survey area, mainly east of Evacuation Creek Canyon. About 45 to 55 percent of the complex is A channery loam on 20 to 40 percent slopes, mainly north-facing; 25 to 30 percent is B channery loam on 20 to 40 percent south-facing slopes. Inclusions are A channery loam on 10 to 20 percent slopes on the broader ridge tops; D channery loam on 5 to 10 percent slopes in small drainageways; and rock outcrop on steep, south-facing slopes.

AB-BB Complex, 5 to 10 percent slopes (A5): This mapping unit occurs to a limited extent in the area east of Evacuation Creek Canyon. One area occurs northeast of the main road in Sections 18 and 20, T10S, R25E10. About 45 to 55 percent of the complex is A channery loam on 5 to 10 percent slopes; 30 to 35 percent is B channery loam on 5 to 10 percent slopes. Inclusions are mainly D channery loam on 5 to 10 percent slopes.

As Soils: As soils consist of shallow channery sandy loams. Soil depth ranges from about 30 cm to 50 cm (12 in. to 20 in.) and overlies bedrock of the Uinta Sandstone Formation. The soils occur in upland settings on 5 to 40 percent slopes. As soils are generally on long, north-facing slopes but also occur in other aspects. These soils occur in association with Bs soils, and most of the mapping units are complexes of both.

Elevations range from about 1,650 m to 1,770 m (5,400 ft to 5,800 ft). Vegetation consists mainly of sagebrush, juniper, shadscale, and yellowbrush. At the higher elevations pinyon pine occurs with the juniper. Average annual precipitation ranges from about 17 cm to 23 cm (7 in. to 9 in.), and the mean annual soil temperature ranges from about 5°C to 7°C (41°F to 45°F).

A representative pedon on a steep, north-facing slope (about 30 percent slope) about 300 m (1,000 ft) north of the southwest corner of Section 23, T10S, R24E follows:

A_{11} 0 cm to 5 cm (0 in. to 2.0 in.)--brown (10YR5/3) channery sandy loam; brown (10YR4/3) when moist; weak, thick, platy structure; soft, very friable, slightly sticky, and non-plastic; many fine roots; moderately calcareous; moderately alkaline (pH 8.0).

A_{12} 5 cm to 12 cm (2.0 in. to 4.7 in.)--brown (10YR5/3 very channery sandy loam; brown (10YR5/3) when moist; massive; soft, friable, slightly sticky, and non-plastic; many fine roots; moderately calcareous; moderately alkaline (pH 8.2).

Cca 12 cm to 25 cm (4.7 in. to 9.8 in.)--pale brown (10YR6/3) very channery sandy loam; brown (10YR5/3) when moist; massive; hard, friable; slightly sticky, and non-plastic; plentiful fine roots; moderately calcareous (pH 8.7).

C_1 25 cm to 35 cm (9.8 in. to 3.8 14 in.)--pale brown (10YR6/3) very channery, very flaggy sandy loam; brown (10YR5/3) when moist; massive; slightly hard, friable, slightly sticky, and non-plastic; few fine roots; moderately calcareous; moderately alkaline (pH 8.9).

R Sandstone bedrock.

As soils are used for wildlife habitat and for winter sheep grazing. Permeability is moderate and runoff is medium. The hazard of erosion is moderate. This soil will hold about 2.5 cm (1.0 in.) of available water.

AsC-BsE Complex, 10 to 50 percent slopes (As1): This moderately extensive mapping unit occurs entirely in the western part of the survey area and is extensive in the Southam Canyon drainage basin. About 40 to 55 percent of the complex is As channery and sandy loam on 10 to 20 percent slopes (AsC), and 25 to 35 percent is Bs channery loam on 30 to 50 percent slopes (BsE). As channery loam on 10 to 20 percent slopes (AsC) occurs on narrow terrace segments and north-facing slopes. Bs channery sandy loam on 30 to 50 percent slopes (BsE) occurs mainly on steep, south-facing and west-facing ledgy escarpments with narrow outcropping sandstone and very shallow soil between the ledges.

Included within this mapping unit are small areas of Ds channery sandy loam on 5 to 10 percent slopes (DsB); As channery sandy loam on 20 to 40 percent slopes (AsD); and rock outcrop (R), a massive sandstone of the Uinta Formation.

As Channery Sandy Loam, 10 to 20 percent slopes (As2): This mapping unit is of very limited extent. It occurs on a high terrace (elevation about 1,780 m (5,840 ft)) on the eastern edge of the Southam Canyon drainage in Sections 26 and 27, T10S, R24E. About 75 to 85 percent of the area is As channery sandy loam on 10 to 20 percent slopes (AsC). Inclusions consist mainly of small areas of Bs channery and flaggy sandy loam (BsD) at the edges of the terrace and small areas of rock outcrop (R). Vegetation consists of black sage, shadscale, rabbitbrush, and scattered juniper.

AsC-BsC Complex, 10 to 20 percent slopes (AsC-Bs3): This mapping unit is of limited extent and occurs mainly in the northwest part of Southam Canyon area on an upland terrace area in Sections 17 and 20, T10S, R24E. About 45 to 55 percent of the complex is As channery sandy loam on 10 to 20 percent slopes (AsC); about 25 to 35 percent is Bs channery and sandy loam on 10 to 20 percent slopes. Inclusions are mainly Ds channery sandy loam on 5 to 10 percent slopes (DsB) and As channery sandy loam on 5 to 10 percent slopes (AsB).

Because of its limited size, a small area of AsB-BsC complex (5 to 20 percent slopes) is included with this complex. This inclusion differs in that it occurs on more gentle

annual precipitation ranges from about 15 cm to 20 cm (6 in. to 8 in.), and the mean annual soil temperature is 4°C to 7°C (40°F to 45°F).

The following is a representative pedon on a 30 percent south-facing slope with sparse growth of shadscale and black sagebrush, located in the southwest quarter of Section 20, T.10S.R.25E.:

A_1 0 cm to 3 cm (0 in. to 1.2 in.)--pale brown (10YR6/3) channery loam; brown (10YR4/3) when moist; weak, thin, platy structure; soft, friable, slightly sticky, and slightly plastic; few fine roots; moderately calcareous; moderately alkaline.

C 3 cm to 20 cm (1.2 in. to 7.9 in.)--pale brown (10YR6/3) very channery loam; brown (10YR4/3) when moist (60 to 70 percent channers and flagstones); slightly hard, friable, slightly sticky, and slightly plastic; few fine and medium roots; moderately calcareous; strongly alkaline.

R Green River Formation.

B soils are used for wildlife habitat and limited grazing. Permeability is moderate. Runoff is medium, and the hazard of erosion is moderate to severe. This soil will hold only about 1.5 cm to 2.5 cm (0.6 in. to 1.0 in.) of available water.

BC-AB Complex, 5 to 20 percent slopes (B1): This mapping unit occurs only in the northeastern part of the area, north of the White River. About 45 to 55 percent of the complex is B channery loam on 10 to 20 percent slopes; 25 to 30 percent is A channery loam on 5 to 10 percent slopes. Inclusions are B channery loam on 5 to 10 percent slopes, D channery sandy loam on 5 to 10 percent slopes, and the Green River Formation. B soils occur mainly on south-facing slopes and ridge tops; A soils are mainly on north-facing slopes; D soils are in the swales; and the Green River Formation outcrops on ridge tops and south-facing slopes, in close association with B channery loam.

BD-Green River Formation Complex, 20 to 40 percent slopes (B2): This unit occurs in the eastern part of the area on rolling hills between Hells Hole Canyon and Evacuation Creek drainage. About 50 to 60 percent of the complex is B channery loam on 20 to 40 percent slopes. About 20 to 30 percent

is the Green River Formation. Inclusions are mainly A channery loam on 10 to 20 percent slopes and D channery sandy loam on 5 to 10 percent slopes in drainage bottoms. BD channery loam occurs on all aspects in this mapping unit. The Green River Formation occurs mainly on ridge tops, knolls, and south-facing hillsides.

Included with this mapping unit is a small area of similar soil on a 5 to 10 percent slope. This area is located in the southeast one quarter of Section 18, T10S, R25E.

BD-AD Complex, 20 to 40 percent slopes (B3): This unit occurs in the southeast portion of the area in Sections 29 and 30, T10S, R25E and in Section 25, T10S, R24E. About 50 to 60 percent of the area is B channery loam on 20 to 40 percent slopes; and about 20 to 25 percent is A channery loam on 20 to 50 percent slopes. Inclusions are mainly rock outcrop of the Green River Formation and D sandy loam on 5 to 10 percent slopes along drainageways.

Bs Soils: Bs soils consist of very shallow channery and flaggy sandy loams. The soil depth ranges from about 5 cm to 25 cm (2 in. to 10 in.) and overlies bedrock of the Uinta Formation. The soils occur in upland settings, with slopes ranging from about 5 to more than 50 percent. B soils occur in association with rock outcrop of the Uinta Formation and with As soils. Bs soils are similar to B soils, but are sandier in texture, and the coarse fragments are sandstone. Elevations range from about 1,620 m to 1,770 m (5,300 ft to 5,800 ft). Vegetation consists of juniper, black sagebrush, shadscale, rabbitbrush, and bluebunch wheatgrass. Average annual precipitation ranges from about 15 cm to 23 cm (6 in. to 9 in.) and the mean annual soil temperature is about 5°C to 7°C (41°F to 45°F).

The following is a description of a representative pedon on a 23 percent west-facing slope with sparse growth of black sage, shadscale, Indian ricegrass, and slender wheatgrass, located in the southwest one quarter of Section 21, T10S, R24E.

A_1 0 cm to 10 cm (0 in. to 3.9 in.)--pale brown (10YR6/3) very channery sandy loam; brown ((10YR4/3) when moist; weak, thin, platy structure; loose, friable, slightly sticky, and slightly plastic; few fine roots; moderately calcareous; moderately alkaline (pH 8.2).

C_1 10 cm to 18 cm (3.9 in. to 7.1 in.)--light yellowish brown (10YR6/4) channery sandy loam; dark yellowish brown (10YR6/4) when moist; massive; loose, friable, slightly sticky, and non-plastic; common fine and medium roots; moderately calcareous; moderately alkaline (pH 8.4).

Cr 18 cm to 23 cm (7.1 in. to 9.1 in.)--shattered flagstones about 1 cm (0.4 in.) thick with thin lime coating on bottom; fine roots between layers of rock.

R Sandstone bedrock.

Bs soils are used for wildlife habitat and limited sheep grazing during winter. Permeability is moderate. Runoff is medium to high, and the hazard of erosion is moderate to severe. This soil will hold about 1.5 cm (0.6 in.) of available water.

BsD-Uinta Sandstone Complex, 20 to 40 percent slopes (Bs1): This mapping unit occurs to a limited extent mainly in the northwestern part of Southam Canyon and in the Asphalt Canyon drainage. About 45 to 55 percent of the complex is Bs channery and flaggy sandy loam on 20 to 40 percent slopes (BsD). About 25 to 35 percent is rock outcrop of the Uinta Formation (R). Inclusions are mainly As channery sandy loam on 20 to 40 percent slopes (AsD) and Ds channery sandy loam on 5 to 10 percent slopes (DsB).

BsE-AsE Complex, 40 to 60 percent slopes (Bs2): This mapping unit is of limited extent. It is located in the corridor in the extreme southern part west of Evacuation Creek. About 50 to 60 percent of the complex is Bs very channery and very flaggy sandy loam located on steep, south-facing slopes. About 25 to 30 percent is As channery sandy loam on 40 to 60 percent slopes and occurs on north-facing slopes. Inclusions are mainly rock outcrop (R) and small areas of Ds channery sandy loam in narrow drainages.

BsE-Uinta Sandstone Complex, 40 to 60 percent slopes (Bs3): This mapping unit is extensive in the western part of the area. About 50 to 60 percent of the complex is Bs very channery and very flaggy sandy loam on 40 to 60 percent slopes. About 30 to 60 percent is rock outcrop of the Uinta Formation. Inclusions are mainly As very channery sandy loam on 20 to 40 percent slopes (AsD).

This complex occurs on all aspects, but is most extensive on south-facing and west-facing escarpments. The vegetation consists mainly of scattered shadscale, rabbitbrush, black sage, and Indian ricegrass.

Bs Channery Sandy Loam, 10 to 20 percent slopes (Bs4): This mapping unit occurs in the western part of the survey area, mainly in Southam Canyon and in the corridor area in the northwestern portion north of the White River. About 75 to 85 percent of this mapping unit is Bs channery sandy loam on 10 to 20 percent slopes. As soil is closely associated with Bs soil and often occurs as small step-like terraces on the uphill side of individual juniper or sagebrush. Also included in this unit are narrow rims of rock outcrop (R) and small areas of Ds channery sandy loam on 5 to 10 percent slopes (DsB) in small drainages. Included with this mapping unit are some small areas of Bs channery sandy loam on 5 to 10 percent slopes.

BsC-Uinta Sandstone Complex, 10 to 20 percent slopes (Bs5): This complex occurs in the western upland portion of the Evacuation Creek drainage and is most extensive in the western half of Sections 26 and 35, T10S, R24E, and in the Asphalt Creek drainage in the extreme western part of the area.

About 55 to 60 percent of the complex is As channery sandy loam on 10 to 20 percent slopes (AsC), and about 20 to 30 percent is rock outcrop (R). Inclusions are mainly Bs channery sandy loam on 20 to 40 percent slopes (BsD) and on 5 to 10 percent slopes (BsB). There are also small areas of As channery sandy loam on 10 to 20 percent slopes (AsC) and Ds channery sandy loam (DsB) in narrow drainages. The vegetation is mainly juniper, sagebrush, and shadscale.

Uinta Sandstone-BsE Complex, 40 to 70 percent slopes (R): This mapping unit is extensive in the central and western parts of the area. About 45 to 55 percent of the complex is massive Uinta sandstone which occurs as ledges and cliffs on very steep slopes. Some of the cliffs extend upward over 30 m (100 ft) from their base to elevations of 1,750 m (5,750 ft). An estimated 30 to 40 percent of the complex is Bs soil (very channery and very flaggy sandy loam) on 40 to 70 percent slopes. The Bs soil usually occurs on small, steep terraces between narrow sandstone ledges. Inclusions consist mainly of small areas of As channery sandy loam on 20 to 40 percent slopes and Bs channery sandy loam on 20 to 40 percent slopes.

Ds Soils: Ds soils consist mainly of sandy loams more than 150 cm (59 in.) deep; however, the total depth to underlying bedrock is not known. The soils are forming in alluvium mainly from Uinta sandstone. The soil occurs in relatively narrow drainages below steep-sloping soils and rock outcrop, and actively-cutting gullies occur in each drainage area. It is most extensive in the Southam Canyon drainage basin but is found in practically all parts of the area. The vegetation is mainly sagebrush with some greasewood, fourwing saltbush, rabbitbrush, and shadscale. The slope range is about 5 to 10 percent.

The average annual precipitation ranges from about 18 cm to 23 cm (7 in. to 9 in.), and the mean annual soil temperature ranges from about 5°C to 7°C (41°F to 45°F).

A representative pedon in a narrow drainageway with a 5 percent slope is located about 370 m (1,200 ft) east of the northwest corner of Section 13, T10S, R24E and is as follows:

A_1 0 cm to 6 cm (0 in. to 2.4 in.)--pale brown (10YR6/3) sandy loam with about 18 percent fine channers; brown (10YR4/3) when moist; weak, thin, platy structure; soft, friable, slightly sticky, and slightly plastic; few very fine roots; moderately calcareous; moderately alkaline (pH 8.0); clear smooth boundary.

C_1 6 cm to 30 cm (2.4 in. to 11.8 in)--light yellowish brown (10YR6/4) channery sandy loam; dark yellowish brown (10YR4/4) when moist; massive; slightly hard, very friable, slightly sticky, and slightly plastic; abundant fine roots; moderately calcareous; moderately alkaline (pH 8.3); gradual smooth boundary.

C_2 30 cm to 137 cm (11.8 in. to 53.9 in.)--light yellowish brown (10YR6/4) channery sandy loam; dark yellowish brown (10YR4/4) when moist; massive; slightly hard; very friable, slightly sticky, and slightly plastic; few fine roots; moderately calcareous; moderately alkaline (pH 8.2).

These soils are used for wildlife habitat and for winter sheep grazing. Permeability is moderate, and runoff is medium. The hazard of erosion is moderate. This soil will hold about 18 cm to 20 cm (7 in. to 8 in.) of available water to a depth of 150 cm (59 in.). Roots penetrate easily.

Ds sandy loam, 5 to 10 percent slopes (D): This is the only unit mapped in the Ds series. It occurs throughout the area but is probably most extensive in the Southam Canyon area. About 75 to 80 percent of the area mapped is Ds sandy loam on 5 to 10 percent slopes (DsB).

Inclusions consist of flaggy sandy loam or channery sandy loam areas, mainly near the heads of drainageways. Small areas with surfaces of loamy sand and channery loamy sand occur mainly in the Southam Canyon drainage. Near the outer edges of some drainages the depth to bedrock varies from 75 cm to 100 cm (30 in. to 40 in.). Included with this mapping unit are a few small areas in the eastern part of the area with loamy texture. In a few locations at the head of drainages the slopes range from 10 to 15 percent.

E Soils: E soils consist of deep, loamy soil. They occur above the present flood plain of the White River, in close association with N soils. Elevations range from about 1,560 m to 1,590 m (5,100 ft to 5,200 ft). Vegetation consists of rabbitbrush, shadscale, cheatgrass, needlegrass, and annual weeds.

Average annual precipitation ranges from about 15 cm to 23 cm (6 in. to 9 in.) and the annual soft temperature is about 5°C to 7°C (41°F to 45°F).

Following is a description of a representative pedon on a stream terrace located about 300 m (1,000 ft) north and 300 m (1,000 ft) west of the center of Section 17, T10S, R24E.

A_1 0 cm to 10 cm (0 in. to 3.9 in.)--brown (10YR5/3) fine sandy loam; brown (10YR4/3) when moist; weak, thin, platy structure; soft, friable, slightly sticky, and slightly plastic; few very fine roots; moderately calcareous; moderately alkaline (pH 8.2).

C_1ca 10 cm to 23 cm (3.9 in. to 9.1 in.)--pale brown (10YR4/3) loam; brown (10YR4/3) when moist; weak, subangular, blocky structure; slightly hard, friable, slightly sticky, and slightly plastic; plentiful fine roots; strongly calcareous; moderately alkaline (pH 8.2).

C_2ca 23 cm to 47 cm (9.1 in. to 18.5 in.)--very pale brown (10YR7/3) loam; yellowish brown (10YR5/4) when moist; moderate, medium, subangular, blocky structure; slightly hard,

friable, slightly sticky, and slightly plastic; few fine roots; strongly calcareous; moderately alkaline (pH 8.4).

C_3ca 47 cm to 75 cm (18.5 in. to 29.5 in.)--light yellowish brown (10YR6/4) loam; yellowish brown (10YR5/4) when moist; massive; slightly hard, friable, slightly sticky, and slightly plastic; strongly calcareous; strongly alkaline (pH 8.6).

C_4 75 cm to 150 cm (29.5 in. to 59.1 in.)--light yellowish brown (10YR6/4) fine sandy loam; yellowish brown (10YR5/4) when moist; massive; slightly hard, friable, slightly sticky, and slightly plastic; moderately calcareous; moderately alkaline (pH 8.1).

EB soils are used for wildlife habitat and winter sheep grazing. Permeability is moderate and runoff is low. The hazard of erosion is slight. This soil will hold 20 cm to 25 cm (8 in. to 10 in.) of available water. Roots penetrate easily.

EB-NB Complex, 5 to 10 percent slopes (EN): This mapping unit is of very limited extent and is located mainly on river terraces south of the White River about 15 m (50 ft) above the present flood plain. About 45 to 55 percent is E fine sandy loam on 5 to 10 percent slope (EB), and about 25 to 35 percent is N sandy loam on 5 to 10 percent slopes (NB). There are inclusions of Ds sandy loam on 5 to 10 percent slopes (DsB), a few knolls and bars of quartzite cobble and gravel, and small areas of rock outcrop. E fine sandy loam is deep, medium textured, and well drained. The soil is calcareous throughout and has a moderately strong calcic horizon in the subsoil.

N sandy loam is deep, moderately well drained, moderately fine textured, and calcareous. The subsoil has strong columnar structure and is strongly affected by sodium.

F Soils: The F soils consist of shallow to very shallow sandy soils that range from about 10 cm to 38 cm (4 in. to 15 in.) deep and overlie sandstone bedrock of the Uinta Formation. The soil occurs in upland settings, and slopes range from about 3 to 7 percent. F soils occur in association with rock outcrop (R) and with Bs sandy loam on 10 to 20 percent slopes (BsC). Elevations range from about 1,590 m to 1,610 m (5,200 ft to 5,280 ft). Vegetation is mainly spring hopsage, rabbitbrush, black sagebrush,

shadscale, and cheatgrass. Average annual precipitation ranges from about 15 cm to 20 cm (6 in. to 8 in.), and the mean annual soil temperature is about 4°C to 8°C (40°F to 45°F).

Following is a description of a representative pedon on a 3 percent slope on a ridgetop located about 400 m (1,300 ft) north and about 210 m (700 ft) east of the southwest corner of Section 13, T10S, R24E.

A_1 0 cm to 4 cm (0 in. to 1.6 in.)--pale brown (10YR6/3) loamy sand; brown (10YR4/3) when moist; weak, fine, platy structure; soft, very friable, nonsticky, and non-plastic; moderately calcareous; moderately alkaline (pH 8.1); clear smooth boundary.

C_1 4 cm to 17 cm (1.5 in. to 6.5 in.)--pale brown (10YR6/3) loamy sand; dark yellowish brown (10YR4/4) when moist; weak, medium, subangular, blocky structure; soft, very friable, nonsticky, and non-plastic; abundant fine and medium roots; moderately calcareous; moderately alkaline, (pH 8.2); clay smooth boundary.

C_2ca 17 cm to 35 cm (6.7 in. to 13.5 in.)--pale brown (10YR6/3) channery loamy sand; dark yellowish brown (10YR4/3) when moist; massive; soft, very friable, nonsticky, and non-plastic; moderately calcareous; moderately alkaline (pH 8.5); sandstone bedrock at 35 cm (13.8 in.).

R Sandstone bedrock

F soils are used for wildlife habitat and limited winter sheep grazing. Permeability is moderate to rapid. Runoff is medium to high, and erosion hazard is moderate to severe. This soil will hold about 1.5 cm to 2.5 cm (0.6 in. to 1.0 in.) of available water.

FB-R Complex, 3 to 7 percent slopes (FR): This complex occurs in the western upland portion of the Evacuation Canyon drainage and is of very limited extent. The main area is in the western part of Section 13 and the eastern part of Section 14, T10S, R24E.

About 40 to 50 percent of the complex is F loamy sand on 3 to 7 percent slopes (FB), and about 35 to 40 percent is rock outcrop. Inclusions are mainly Bs sandy loam on

10 to 20 percent slopes (BsC) and Ds sandy loam on 5 to 10 percent slopes (DsB).

F loamy fine sand is a shallow to very shallow sandy soil over sandstone bedrock of the Uinta Formation.

N Soils: N soils consist of deep, moderately fine textured soils that occur mainly on stream terraces. They are most extensive on terraces about 15 m (50 ft) above the present flood plain of the White River. These soils also occur on terraces above the present flood plain of Evacuation Creek. Slopes range from about 5 to 10 percent; however, slopes are mainly about 5 percent. On the White River terraces, N soils are closely associated with E soils, and the mapping units are complexes of these two soils. Along Evacuation Creek the N soils are associated with Ds soils and the mapping unit is a complex of N and Ds soils. Elevations range from about 1,550 m to 1,580 m (5,100 ft to 5,200 ft). Vegetation consists mainly of greasewood, shadscale, hopsage, and annual weeds. The average annual precipitation ranges from about 18 cm to 23 cm (7 in. to 9 in.), and the mean annual soil-temperature ranges from about 5°C to 7°C (41°F to 45°F).

The following is a description of a representative pedon on a stream terrace on the west side of Evacuation Creek, about 152 m (500 ft) east of the south side and center of Section 13, T10S, R24E.

A_2 0 cm to 9 cm (0 in. to 3.5 in.)--pale brown (10YR6/3) fine sandy loam; brown (10YR4/3) when moist; weak, thin, platy structure; soft, friable, slightly sticky, and slightly plastic; few fine roots; moderately calcareous; strongly alkaline (pH 8.7); clear smooth boundary.

B_{21} 9 cm to 20 cm (3.5 in. to 7.9 in.)--reddish brown (5YR3/3) when moist; strong, coarse, prismatic structure; very hard, firm, sticky, and very plastic; few fine roots; thin, nearly continuous clay films; strongly calcareous; strongly alkaline (pH 8.9); clear smooth boundary.

B_{22} 20 cm to 34 cm (7.9 in. to 13.4 in.)--light brown (7.5YR6/4) silty clay loam; brown (7.5YR4/4) when moist; moderate, medium, prismatic, breaking to strong, medium, subangular, blocky structure; hard, firm, sticky, and plastic; moderately calcareous; strongly alkaline (pH 8.5); gradual wavy boundary.

NB-DsB Complex, 5 to 10 percent slopes (ND): This mapping unit occurs mainly along narrow terraces on both sides of Evacuation Creek. About 45 to 55 percent of the complex is N fine sandy loam on 5 to 10 percent slopes (NB), and about 25 to 35 percent is Ds sandy loam on 5 to 10 percent slopes. The NB soil is deep, moderately well drained, and moderately fine textured. The subsoil has strong columnar structure and is strongly affected with alkali. Ds soils are deep, well drained, and moderately coarse textured. Inclusions consist mainly of E fine sandy loam on 5 to 10 percent slopes (EB) and the immediate channel area of Evacuation Creek. There are also small areas of rock outcrop.

W Soils: W soils are deep and imperfectly drained, form in silty alluvium deposited by the White River, and occur adjacent to the present floodplain of the river. The area is about 1/3 km (1/2 mi) wide and extends along the northern corridor of the project area. Vegetation consists mainly of large cottonwood trees, tamarisk, rabbitbrush, and saltgrass. Slopes are generally less than 2 percent. Average annual precipitation ranges from about 18 cm to 23 cm (7 in. to 9 in.), and the mean annual soil temperature ranges from about 5°C to 7°C (41°F to 45°F).

Following is a description of a representative pedon in an area of large cottonwood trees with an understory of saltgrass and rabbitbrush, located in the northwest quarter of Section 17, T10S, R24E.

A_1 0 cm to 10 cm (0 in. to 3.9 in.)--grayish brown (10YR5/2) silt loam; brown (10YR4/3) when moist; thin, medium, platy structure; slightly hard, friable, slightly sticky, and slightly plastic; strongly calcareous; moderately alkaline (pH 8.2).

A_{12} 10 cm to 20 cm (3.9 in. to 7.9 in.)--pale brown (10YR6/3) silt loam; brown (10YR5/3) when moist; massive; slightly hard, friable, slightly sticky, and slightly plastic; strongly calcareous; moderately alkaline (pH 8.2).

C_1 20 cm to 65 cm (7.9 in. to 25.6 in.)--pale brown (10YR6/3) silty clay loam; brown (10YR4/3) when moist; massive; hard, firm, sticky, and plastic; strongly calcareous; moderately alkaline (pH 8.0).

C_2 65 cm to 120 cm (25.6 in. to 47.2 in.)--pale brown (10YR6/3) fine sandy loam; brown (10YR4/3)

C_1ca 34 cm to 55 cm (13.4 in. to 21.7 in.)--light brown (7.5YR6/4) silty clay loam; brown (7.5YR5/4) when moist; massive; hard, firm, sticky, and plastic; strongly calcareous; moderately alkaline (pH 8.2); gradual boundary.

C_2ca 55,6 cm to 89 cm (21.7 in. to 35.0 in.)--light brown (7.5 YR6/4) silty clay loam; brown (7.5YR5/4) when moist; massive; hard, firm, sticky, and plastic; strongly calcareous; moderately alkaline (pH 8.1); gradual boundary.

C_3 89 cm to 158 cm (35 in. to 62 in.)--light brown (7.5YR6/4) heavy loam; brown (7.5YR5/4) when moist; massive; slightly hard, friable, slightly sticky, and slightly plastic; moderately calcareous; moderately alkaline (pH 8.3).

N soils are used for wildlife habitat and winter sheep grazing. Runoff is moderate to rapid. Permeability is low, and the hazard of erosion is moderate. This soil will hold about 15 cm to 20 cm (6 in. to 8 in.) of water to a depth of 150 cm (59 in.).

NB-EB Complex, 5 to 10 percent slope (NE): This mapping unit is limited in extent. It occurs mainly on gently-undulating river terraces on the north and south sides of the White River. These terraces are about 15 m to 23 m (50 ft to 75 ft) above the present river flood plain. The areas are not continuous but occur as small isolated areas, mainly on the north side of the White River. About 45 to 55 percent of the complex is N fine sandy loam on 5 to 10 percent slopes (NB). About 25 to 35 percent is E fine sandy loam on 5 to 10 percent slopes (EB). The NB soil is deep, moderately well drained, and moderately fine textured. The subsoil has strong columnar structure and is strongly affected with sodium. The EB soil is deep, medium textured and well drained. The soil is calcareous throughout and has a moderately strong calcic horizon in the subsoil. Inclusions consist mainly of Ds sandy loam on 5 to 10 percent slopes (DsB) and a few knolls and bars consisting of quartzite cobble and gravel that contain very little fine soil material.

Included with this unit is an area in the southeast quarter of Section 2, T10S, R24E. This area is on the south side of the White River at Ignacio. About 75 to 85 percent of this area is NB soil. Much of it is seriously eroded and much of the original surface soil removed. Inclusions are mainly knolls of quartzite cobble and gravel. Because of its small size, this area was not mapped separately.

when moist; massive; soft, friable, slightly sticky, and slightly plastic; moderately calcareous; moderately alkaline (pH 8.2). Distinct brownish yellow (10YR6/6) mottles below 90 cm (35.4 in.).

C_3 120 to 195 cm (47.2 to 76.8 in)--pale brown (10YR6/2) silt loam; brown (10YR4/3) when moist; massive; slightly hard, friable, slightly sticky, and slightly plastic; strongly calcareous; moderately alkaline (pH 8.1). Distinct brownish-yellow (10YR6/6) mottles.

This soil is used for wildlife habitat and summer cattle grazing. Permeability is moderate and runoff is low. The soil will hold 20 cm to 25 cm (8 in. to 10 in.) of available water.

W silt loam, 0 to 2 percent slopes (W): This is the only unit mapped in the Ws series. About 70 to 80 percent of the area mapped is W silt loam on 0 to 2 percent slopes. Inclusions consist mainly of deep, fine sand, loamy sand, or stratified sandy loam and sand. The sandier inclusions are mainly along more recent bars and beaches of the White River. Vegetation is mainly a young growth of tamarisk, willows, and rabbitbrush. Also included in the unit is the present stream channel of the river.

b. Soil Formation

The characteristics of a soil at any given point are determined by the interaction of five principal soil factors: (1) parent material; (2) climate; (3) topography, relief; (4) biota, e.g., plants, animals and man; and (5) time.

The soils along the flood plain of the White River and along smaller drainageways throughout the area have formed in alluvium. The alluvium along the White River has come from a wide range of transported materials, whereas in the smaller drainages the materials are largely deep sandy loams and channery sandy loams from the local Uinta and Green River formations. The parent material for the upland soils that comprise a large portion of the area is mainly the Uinta Formation and the Green River Formation. The soils are mainly shallow or very shallow overlying these formations.

Two important climatic factors in the formation of soils on the tracts are precipitation and temperature. There are no data for this specific area, but data are available for Vernal, Utah, where the average yearly precipitation is about 20 cm (8 in.), and the average precipitation is about 1.5 cm (0.6 in.) per month from October through March and from June through July, and about 2.0 cm (0.8 in.) per month during April, May, September, and October. On the tracts the average annual soil temperature at a 51 cm (20 in) depth is estimated to be slightly less than 8°C (47°F), which places the soils in the frigid soil family.

The tracts are in the Colorado Plateau physiographic province. The province is distinguished by the approximate horizontality of the bedrock and the numerous canyons and generally high elevation. Most of the area is between 1,520 m and 1,830 m (5,000 ft and 6,000 ft) above sea level. The topography of the area is sloping to steep slopes ranging from about 5 percent to over 60 percent. The western part of the survey area is characterized by numerous nearly vertical sandstone cliffs. The eastern part of the area, east of Evacuation Creek has more rolling topography and fewer sandstone cliffs.

Vegetation influences soil formation mainly through the addition of organic matter from leaves, stems, and roots. Shrubs, forbs, and grasses are the dominant vegetation over much of the area. Juniper trees are common at higher elevations, above 1,650 m (5,400 ft) west of Evacuation Creek, with scattered pinyon pine at the highest elevations. An open stand of large cottonwood trees occurs along the White River valley. Young willows and tamarisk occur in the most recent deposits. Big sagebrush is the dominant vegetation along numerous drainageways throughout the area. Shadscale, black sage, cheatgrass, Indian ricegrass, squirreltail, and some forbs are common on shallow upland soils. Greasewood and shadscale are common in alkali-affected areas. Burrowing animals are important in mixing the various soil materials, and the mounds and disturbed areas are conspicuous in the survey area. Grazing animals also affect soils by removing vegetation, which tends to increase erosion. Man has affected soil development in the area by building roads and trails, which contribute to erosion.

Time is essential in soil formation, whether a few years or centuries. Entisols, for instance, such as the Typic Torrifluvents, along the drainageways, are young soils that have not been in place and undisturbed long enough for distinct horizons to develop. Typic Natrargids are examples of soils with well-differentiated horizons. These

soils occur on higher terraces, which implies greater age, or more time for soil-forming processes to act.

c. Soil Classification

The nine different soil types found on the tracts are classified on Table V-1. Table V-1 shows the two soil orders of Entisols and Aridisols. Soil orders are soils with similar sets of soil-forming processes. Entisols are soils that lack distinct horizons and Aridisols are generally dry and have light-colored or thin surface horizons with well-expressed lime horizons (calcic horizon) or sodic horizons (natic horizon).

Soil orders are divided into suborders, primarily on the basis of closest genetic similarity. The suborders in the survey area, identified by the last two syllables of the subgroup, are orthids, orthents, fluvents, and argids. The basis for this division is differences resulting from climate or vegetation, or the presence or absence of water-logging.

The great group is a subdivision of the suborder. An example of a great group name is Calciorthid, which are aridisols with a strong calcic horizon. Great groups are based on the uniformity in the kinds and sequence of major soil horizons and properties. The horizons used to make separations are those in which clay, iron, humus, or lime have accumulated, or those that have layers that interfere with root growth or the movement of water. Properties used also include soil temperature and major differences in chemical composition.

Great groups are divided into subgroups. There is a central (typic) concept of the group, and intergrades that have slightly different properties. Lithic Calciorthid is a subgroup that indicates a shallow soil less than 51 cm (20 in.) to bedrock with a strong calcic horizon.

Families are based on the properties important to the growth of plants or to engineering. Among the properties considered are texture, mineralogy, reaction, and soil temperature. Coarse-loamy, for example, indicates a sandy-loam texture; mixed indicates the clay mineralogy is varied. Frigid indicates that the mean annual soil temperature 51 cm (20 in.) deep is less than 8°C (47°F). Soils with mean annual temperatures below 47°F are considered too cold for most farm crops to mature.

TABLE V-1

SOILS CLASSIFICATION

Soil	Family	Subgroup	Order
A	Loamy-skeletal, mixed, frigid	Lithic Calciorthid	Ardisols
As	Loamy-skeletal, mixed, frigid	Lithic Calciorthid	Aridisols
B	Loamy-skeletal, mixed (calcareous) frigid	Lithic Torriorthent	Entisol
Bs	Loam-skeletal, mixed (calcareous) frigid	Lithic Torriorthent	Entisol
Ds	Coarse-loamy, mixed (calcareous) frigid	Typic Torrifluvent	Entisol
E	Coarse-loamy, mixed, frigid	Typic Calciorthid	Aridisol
F	Coarse-loamy, mixed (calcareous) frigid	Lithic Torriorthent	Entisol
N	Fine, mixed frigid	Typic Natrargid	Aridisol
W	Fine, mixed (calcareous) frigid	Aquic Ustifluvent	Entisol

The soils were not classified into soil series because of the limited size of the survey area.

d. Laboratory Analysis of Soils

Soils were sampled by horizon from selected locations and analyzed by the USU Cooperative Soils Laboratory (U. S. Dept. of Agriculture, 1967). The soils were analyzed for physical and chemical properties important to characterizing and classifying the soils. The laboratory data sheets are presented in Appendix V-1. Table V-2 gives selected data for the different soils, including soil type, depth sampled, particle size distribution; textural class; reaction, or pH; organic carbon; electrical conductivity; calcium carbonate equivalent percent; extractable cations (Mg, Na and K); available P; and percentage of moisture at saturation.

The following is an explanation of the soil-sample analyses shown in Table V-2. The textural class varies from silty loams, sandy loams, clay loams, and loams. The pH of the samples vary from about 7.8 to 8.9, not especially high for soil high in calcium carbonate. Extractable sodium is moderate except in Soil N which shows 11 to 20 milliequivalents of Na per 100 g of soil. In other upland soils the extractable sodium is highly variable, and occasionally increases in horizons near bedrock.

The organic carbon content of the surface soils varies from 0.5 percent to 2.6 percent, and generally decreases with depth, which is typical for soils in this setting. The exception is soil W, which has 5 percent organic carbon in the surface layer.

Electrical conductivity, or salinity, is generally low, especially in the upper 40 cm (16 in.). The exception is soil N with electrical conductivity values ranging from less than 3 mmhos/cm at 20 cm (8 in.) to 33 mmhos/cm at 34 cm (13 in.) depth. Soil W conductivity varies from less than 2 mmhos/cm in the surface to 28 mmhos/cm at 130 cm (51 in.).

The calcium carbonate equivalent varies from about 3 percent to 30 percent in surface layers and 5 percent to 50 percent in the subsoils. The values are typical for soil formed from calcareous rocks in areas with less than 15 cm to 23 cm (6 in. to 9 in.) of annual precipitation.

The values of extractable cations are typical for a soil formed from saline calcareous sandstone with these climatic conditions.

TABLE V-2

LABORATORY ANALYSIS OF SELECTED SOILS

Soil Name & Collec. No.	Depth From Surface (cm)	Size Class and Diameter of Particles: Very Coarse Sand 2-1 mm	Coarse Sand (1-0.5 mm)	Medium Sand (0.5-.25mm)	Fine Sand (0.25-.10mm)	Very Fine Sand (0.10-0.05mm)	Silt (0.05-.002 mm)	Clay <0.002 mm	% Sand	% >2mm	Textural Class	pH Satur. Paste	Organ. Carbon	Elect/ Conduct mmhos/cm	$CaCo^3$ Equiv. %	Extract. Cations NH_4OA_c Me/100g.: Mg	Na	K	Avail. P ppm	% Moist. Satur.
A #68	0-8	7	4	4	15	18	38	14	48	28	L	8.1	1.5	.5	2.9	1.0	.5	.4	7.5	32
	8-20	10	6	4	13	12	40	20	40	55	L	8.1	1.4	.6	8.4	1.1	1.1	.2	2.0	47
	20-33	22	11	5	8	7	35	17	48	44	L	8.6	1.0	.8	9.8	.6	4.6	.1	1.1	44
	33-50	17	10	6	13	10	26	17	47	77	L	8.7	0.9	1.2	5.3	.6	10.4	.2	2.8	48
As #67	0-5	10	9	12	19	9	27	14	59	39	SL	8.0	1.4	.5	7.0	.4	.4	.3	6.9	38
	5-12	13	8	8	20	15	28	15	58	60	SL	8.2	1.5	.6	8.6	1.0	1.3	.1	1.6	52
	12-25	14	9	7	16	12	34	14	52	67	SL	8.7	1.2	1.0	10.7	1.6	7.2	.1	1.1	51
	25-35	18	12	8	20	11	32	13	65	63	SL	8.9	0.6	1.8	7.9	1.6	8.4	.1	.8	40
B & Bs #63	0-8	9	8	7	17	11	38	20	42	44	L	8.0	.5	.7	7.2	1.5	.9	.2	4.9	28
	8-14	7	4	3	7	8	55	21	24	40	Sil	7.5	.7	1.7	11.4	3.3	5.8	.2	2.1	42
	14-27	6	3	1	5	11	60	25	15	52	Sil	8.3	.5	2.5	14.2	3.5	10.9	.2	.5	44
Ds #64	0-10	9	9	11	21	11	27	11	62	13	SL	8.1	1.1	.6	5.8	1.1	.3	.3	17.0	32
	10-40	14	14	14	23	9	19	11	70	24	SL	8.1	.5	.4	5.9	.9	.5	.1	3.6	30
	40-65	12	14	13	20	9	23	12	65	20	SL	8.1	.4	.6	9.2	.5	.8	.1	3.7	31
	65-113	11	16	15	21	9	21	11	68	15	SL	8.1	.4	2.6	7.5	.9	3.8	.1	4.1	33
	113-150	12	12	13	22	11	23	10	67	21	SL	8.1	.3	28.0	7.2	.5	12.9	.2	2.4	29
E #76	0-10	2	2	3	15	32	31	8	61	2	SL	8.2	.6	.5	5.2	1.5	.3	.5	7.9	31
	10-23	1	1	2	9	23	41	16	43	1	L	8.2	.5	.7	12.5	2.6	.6	.2	1.3	33
	23-47	1	1	1	6	24	45	23	32	0	L	8.4	.4	.7	18.7	3.3	1.7	.2	.8	37
	47-75	3	3	6	20	17	33	19	48	3	L	8.6	.3	.9	11.9	2.4	3.5	.2	.7	31
	75-120	4	6	8	22	14	29	14	57	14	SL	8.1	.4	4.2	9.4	1.7	5.2	.1	1.0	34
	120-150	8	8	9	22	13	25	14	61	26	SL	8.0	.4	18.0	7.8	1.7	10.1	.2	1.4	30
F #39	0-4	2	11	30	29	8	9	8	83	4	LS	8.1	.5	.6	3.0	1.0	.3	.4	16.0	29
	4-17	6	13	30	25	6	11	11	78	7	SL	8.2	.5	.5	3.7	1.3	.5	.2	3.2	32
	17-35	11	19	27	21	5	8	10	72	25	LS	8.5	.5	.3	6.8	1.0	.5	<.1	1.0	38
N #48	0-9	1	1	3	16	33	33	10	37	1	SL	8.7	.3	.9	4.5	2.4	1.7	.9	6.4	28
	9-20	<1	1	2	12	26	34	27	39	1	L	8.9	.3	2.4	10.5	3.9	11.4	.3	3.4	48
	20-34	<1	1	2	8	15	35	38	27	0	CL	8.5	.3	14.0	15.2	5.7	19.8	.2	1.8	62
	34-55	<1	1	3	12	16	35	31	34	1	CL	8.2	.2	33.0	15.5	5.7	19.6	.2	1.0	48
	55-89	<1	1	2	7	21	40	30	30	0	CL	8.1	.2	22.0	15.4	5.0	15.7	.1	1.0	48
	89-158	1	2	2	8	17	46	26	28	2	L	8.3	.1	20.0	11.7	5.0	13.5	.2	.6	49
W #75	0-10	7	1	1	1	2	62	23	15	0	Sil	8.2	5.1	1.4	11.3	5.9	1.3	2.7	27.0	67
	10-20	<1	<1	<1	1	2	69	17	34	0	Sil	8.2	1.1	1.5	11.0	4.0	1.6	1.7	2.1	47
	20-30	<1	<1	<1	<1	<1	58	38	4	0	SiCl	8.0	1.2	14.0	12.0	8.9	7.8	1.5	2.0	65
	30-[illegible]	<1	<1	<1	<1	<1	34	58	4	0	SiCl	8.1	1.0	24.0	11.4	11.5	13.3	.7	2.2	60
	[illegible]	<1	<1	<1	<1	<1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	14.0	14.0	.7	1.2	33

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The available phosphorus is highly variable but is concentrated in the surface soil and decreases markedly with increasing depth. The percentage of moisture at saturation is the percentage by weight of water the soil can hold. The moisture-holding capacity depends on texture, organic matter, structure, and other factors.

The results of X-ray analysis of 15 soil samples are shown in Table V-3. The type of clay minerals present are determined by this method. Clay mineralogy is the basis for classifying the soil at the family level. Boron at selected depths of five soils, shown in Table V-4, ranges from 0.2 ppm to 1.4 ppm.

According to Richards (1954):

> Permissible limits for boron in the saturation extract of soils can at present be given only on a tentative basis. Concentrations below 0.7 ppm boron probably are safe for sensitive plants; from 0.7 to 1.5 ppm boron is marginal; and more than 1.5 ppm boron appears to be unsafe. The more tolerant plants can withstand higher concentrations, but limits cannot be set on the basis of present information.

e. Use and Management of Soils

The area is managed by BLM. It is used mainly as winter range for sheep; however, some cattle use the bottomlands along the White River for summer range. Mule deer are the principal game species that use the range.

Table V-5 gives the estimated herbage yields for favorable and unfavorable years and capability classes for the nine soils. The capability classes indicate the suitability of the soils for most kinds of crops. The classes are designated I through VIII. (The numerals indicate progressively greater limitations and narrower choices for practical use.) The nine soils in the area were placed in two capability classes, VI and VII. Class VI soils have severe limitations that generally make them unsuited to cultivation and limit their use largely to pasture or range, woodland or wildlife. Class VII soils have very severe limitations that make them unsuited to cultivation and restrict their use largely to range, woodland, or wildlife.

The "e" shows that the main limitation is the risk of erosion; the "w" indicates that the soil is wet.

TABLE V-3

RESULTS OF X-RAY ANALYSIS OF 15 SOIL SAMPLES
FROM OIL SHALE TRACTS U-a AND U-b

Soil	Sample #	Depth (cm)	Quartz	Calcite	Dolomite	Feldspar	Illite	Kaolinite	Montmorillonite
D_s	22	25-36	X	X	?	X	X-1	X-1	
A	37	8-22	X	X		?	X-5	X-5	X-1
A	38	27-53	X	X		X	X-5		X-1
A	39	17-35	X	X		X		X-5	X-1
B_s	40	31-137	X	X		X		X-5	X-1
B_s	42	41-60	X	X	X		?	?	X-1
E	45	40-76	X	X					X-1
E	46	20-45	X	X		X	X-4	X-5	X-1
A	48	55-89	X	X		X	X-2	X-3	X-1
A	50	11-30	X	X		X			X-1
A_s	53	23-45	X	X					X-1
A_s	54	17-30	X	X				X-5	X-1
D_s	55	40-120	X	X			X-1	X-1	?
D_s	58	34-72	X	X		X	X-5	X-5	X-1
D_s	63	14-27	X	X	?	X	X-5	X-5	X-1

X means the mineral appears in the less than 2μ fraction. The clay minerals are ranked in order of abundance, with 1 being most abundant and 5 least abundant. Abundances are only estimates.

TABLE V-4

RESULTS OF THE BORON TESTS ON SOIL SAMPLES FROM TRACTS U-a AND U-b

Soil	Pedon #	Depth (cm)	Boron (ppm)
Ds	#64	10-40	0.3
	#63	113-150	0.4
W	#75	30-65	0.4
	#75	130-195	0.2
E	#76	120-150	0.5
Ds	#45	40-76	1.4
	#45	76-121	0.9
N	#48	20-34	1.3
	#48	34-55	1.0

TABLE V-5

ESTIMATED HERBAGE* YIELDS IN KG/HA AND
LAND USE CAPABILITY CLASSES OF SOILS

Soil	Yields		Capability Classes
	Favorable yrs. Kg/ha	Unfavorable yrs. Kg/ha	
A	800	400	VIe
B	400	200	VIIe
As	1000	600	VIIe
Bs	450	250	VIIe
D	1250	900	VIe
E	1250	900	VIe
F	400	200	VIIe
N	150	100	VIIe
W	3500	2000	VIw

*Total yield of above-ground plant parts

Conversion from kg/ha to lb./ac is made by multiplying kg/ha values by 0.9.

The high erosion potential in the area is closely related to the topography. Seventeen mapping units out of a total of 26 have slopes of over 10 percent. Six units have slopes ranging from 5 percent to 10 percent. Two mapping units have slopes of 3 percent to 8 percent. Only one unit has slopes less than 2 percent.

f. Engineering Uses of the Soils

For any engineering use, it is important to consider certain physical characteristics of a soil, including permeability, strength, compaction characteristics, drainage, shrink-swell potential, grain size, plasticity, and reaction. Also important are slope, depth to bedrock and depth to water table.

Table V-6 (U. S. Dept. of Agriculture, 1971) gives the estimated and measured properties of soils on the site, including slope, depth to bedrock, texture class, Unified System and AASHO classification, liquid limit, plastic limit, permeability, available water capacity, pH, electrical conductivity, shrink swell potential, and hydrologic soil group.

The two systems used most frequently in classifying soils for engineering are the Unified System used by the SCS, the U. S. Bureau of Reclamation, the Department of Defense, and the U. S. Corps of Engineers, and the AASHO system adopted by the American Association of State Highway Officials (Am. Assoc. of St. Hwy Officials, 1955). In the Unified System, soils are classified according to particle-size distribution, plasticity, liquid limit, and organic matter. Soils are grouped into 15 classes. There are eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; and six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, OH, and PT. Soils on the borderline between the two classes are designated by symbols for both classes, for example ML-CL.

The AASHO system is used to classify soils according to properties affecting highway construction and maintenance. In this system soils are placed in one of seven basic groups, ranging from A-1 through A-7, on the basis of grain-size distribution, liquid limit, and plasticity index. Group A-1 comprises gravelly soils of high bearing strength. At the other extreme is group A-7, comprising clay soils that have low strength when wet and are the poorest for subgrade. Where laboratory data are available to justify a further breakdown, group A-1, A-2 and A-7 may be divided into subgroups, such as A-2-4.

TABLE V-6

ESTIMATED AND MEASURED SOIL PROPERTIES SIGNIFICANT TO ENGINEERING REQUIREMENTS

Soil	Slope Range (%)	Depth to Bedrock (cm)	Texture Class	Unified	AASHO	Liquid Limit	Plastic Limit	Permeability (In/Hr)	In/In Available Water Capacity	pH	ECe mmhos/cm	Shrink-Swell Potential	Hydrologic Soil Groups
A	3 to 40	30 to 50	channery loam	SM GC	A-2-4	24-33	NP-0	1.0-2.5	0.09-0.11	7.5-8.7	0.4-5.4	Low	C (moderately high runoff potential)
As	5 to 60	30 to 50	channery sandy loams	SM GM	A-2-4	24-36	NP	1.5-3.0	*0.1	8.1-8.5	0.3-6.0	Low	C (moderately high runoff potential)
**B	5 to 40	5 to 25	channery loams	SM GM	A-2-4	20-30	NP	1.0-2.5	*0.1	7.5-8.2	0.7-3.0	Low	D (high runoff potential)
**Bs	10 to 60	5 to 25	channery sandy loams	SM GM	A-2-4	20-30	NP	1.5-3.0	*0.1	7.5-8.3	0.7-2.5	Low	D (high runoff potential)
Ds	5 to 10	150+	sandy loam to channery sandy loam	SM	A-2-4	20-23	NP	1.0-2.4	0.12-0.14	7.9-8.3	1.0-19.0	Low	B (moderately low runoff potential)
E	5 to 10	150+	fine sandy loams to loams	ML CL SM	A-4 A-6	20-27	NP-8	1.0-2.5	0.14-0.16	7.7-8.6	0.4-18.0	Low	B (moderately low runoff potential)
**F	3 to 7	10 to 40	loamy sands	SM	A-2	20-30	NP	2.0-4.0	*0.1	8.1-8.5	0.3-0.6	Low	D (high runoff potential)
**N	5 to 10	150+	fine sandy loam surface silty clay loam subsoil	CL	A-4 or A-6	20-30	5-15	0.05-0.20	0.14-0.16	8.1-8.9	5.0-15.0	Moderate	D (high runoff potential)
W	0 to 2	150+	silt loams to silty clay loams - some sands	CL SM	A-4 A-6	20-47	2-16	0.20-1.50	0.16-0.18	8.0-8.3	1.5-28.0	Moderate	B (moderately low runoff potential)

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Hydrologic soils groups are used in watershed planning to estimate runoff from rainfall. The soil properties considered are those influencing the minimum rate of infiltration of a bare soil after prolonged wetting. These properties are depth of seasonally high water table, intake rate and permeability after prolonged wetting, and depth to very slowly permeable layers. The influence of ground cover is considered independently.

Soils with a low runoff potential have high, or rapid, infiltration rates even when thoroughly wetted, and consist mostly of deep, well to excessively drained sands or gravels. They also have a high rate of water transmission.

Soils with a moderately low runoff potential have moderate infiltration rates when thoroughly wetted and consist mainly of moderately deep to deep, moderately well drained to well drained soils with moderately fine to moderately coarse textures and moderately slow to moderately rapid permeability. They also have a moderate rate of water transmission.

Soils with a moderately high runoff potential have slow infiltration rates when thoroughly wetted and consist mainly of soils with a layer that impedes downward movement of water, soils with moderately fine to fine texture, soils with slow infiltration due to salts or alkali, or soils with moderate water tables. They may be somewhat poorly drained. There are also well drained and moderately well drained soils that have slowly permeable and very slowly permeable layers (hardpans, hard bedrock) at moderate depths 50 cm to 100 cm (20 in. to 39 in.).

Soils with a high runoff potential have very slow infiltration rates when thoroughly wetted and consist mainly of clay soils with a high swelling potential; soils with a permanent high water table; soils with a claypan or clay layer at or near the surface; soils with very slow infiltration due to salts or alkali; and shallow soils over nearly impervious material. They also have a very slow rate of water transmission.

In Table V-6, the estimates of permeability are for soils in place and are based on the structure, texture, and porosity of the soil material and on field observations. The available water capacity, given in inches per inch of soil, is the capacity of the soil to hold water available for most plants. It is commonly defined as the difference between the amount of water in the soil at field capacity and the amount at wilting point.

silty clay loams - some sands

* less than
** estimate

The shrink-swell potential is an indication of the volume change to be expected of the soil material with changes in moisture content. In general, soils with a high shrink-swell potential are hazardous if used in building materials or as a foundation.

The reaction is the intensity of acidity or alkalinity of a soil, expressed in pH values. A pH of 7.0 is neutral; a lower value indicates acidity and a higher value indicates alkalinity. The pH values range from about 7.8 to 8.9. Since these values are not especially high for soils high in calcium carbonate, the corrosiveness of the soil solution would not seriously damage pipelines. Salinity affects the suitability of the soil for plants, its stability when used as construction material, and its corrosiveness to other materials.

Table V-7 gives the interpreted engineering properties of soils, including ratings of soils as a source of topsoil, sand, gravel, roadfill, sanitary landfill cover materials, and cover of spent shale deposits; and rating of their limitations as foundations for low buildings, septic tank filter fields, sewage lagoons, and shallow excavations. Soil features affecting their use as pond-reservoir areas or for embankments to hold water are also shown. Interpretations are based on test data and field experience with soils in the area and similar soils in other areas. It should be emphasized that the interpretations made in this survey are not a substitute for on-site sampling and testing needed at a site chosen for specific engineering work that involves heavy loads, or a site where excavations are deeper than the depths of the layers here reported.

The soils were rated on the degree and kind of limitation affecting their use as septic tank absorption fields, sewage lagoons, sanitary landfill, dwellings with and without basements, and local roads and streets. The ratings are as follows:

"Slight" means that the soil has a few limitations that are easily overcome.

"Moderate" means that the soil has limitations that can generally be overcome by proper planning, careful design, and good management.

"Severe" means that the soil limitations are severe enough to make the use of the soil questionable. Engineering designs to overcome the limitations are difficult and expensive.

TABLE V-7

INTERPRETATIONS OF ENGINEERING PROPERTIES OF SOILS

Soil	Degree and Kind of Limitation for: Septic Tank Absorption Fields	Sewage Lagoons	Sanitary Landfill: Trench type	Sanitary Landfill: Area type	Shallow Excavations	Dwellings w/without Basements	Local Roads & Streets	Suitability as a Source of: Roadfill	Sand	Gravel	Topsoil	Sanitary Landfill Cover Materials	Cover for Scent Shale Deposits	Soil Features Affecting: Pond Reservoir Areas	Dikes, Levees and Other Embankments
A	Severe-slope depth	Severe-slope depth	Severe-depth slope	Severe-depth slope	Severe-depth slope	Severe-depth slope	Severe-depth slope	Good to fair A-2-4	Unsuited loam	Poor loam shallow	Poor channery & flaggy	Poor shallow	Poor shallow	shallow, slope	shallow, stones
As	Severe-slope depth	Severe-slope depth	Severe-depth slope	Severe-depth slope	Severe-depth slope	Severe-depth slope	Severe-depth slope	Good to fair A-2-4	Unsuited sandy loam	Poor sandy loam shallow	Poor very channery and flaggy	Poor shallow	Poor shallow	shallow, slope	shallow, stones
B	Severe-slope depth	Severe-slope depth	Severe-depth slope	Severe-depth slope	Severe-depth slope	Severe-depth slope	Severe-depth slope	Good to fair A-2-4	Unsuited loam	Poor loam shallow	Poor very channery and flaggy	Poor very shallow	Poor very shallow	shallow, slope	very shallow, stones
Bs	Severe-slope depth	Severe-slope depth	Severe-depth slope	Severe-depth slope	Severe-depth slope	Severe-depth slope	Severe-depth slope	Good to fair A-2-4	Unsuited sandy loam	Poor sandy loam shallow	Poor very channery and flaggy	Poor very shallow	Poor very shallow	shallow, slope	very shallow, stones
Ds	Slight-5 to 10% slopes	Moderate-5 to 10% slope	Slight	Slight	Slight	Slight	Slight	Good to fair A-2-4	Unsuited sandy loam	Unsuited	Fair Channer Content increases with depth	Fair to good	Fair to good	moderate to slo- permeability	medium to high susceptibility to piping, medium shear strength
E	Slight-5 to 10% slope	Moderate-5 to 10% slope	Slight	Slight	Slight	Slight	Slight	Fair A-4 A-6	Unsuited sandy loam and loam	Unsuited	Fair to 20 cm strong Ca horizon below	Fair to good	Fair to good	moderate to slow permeability	medium to high susceptibility to piping, medium to low shear strength
F	Severe-depth	Severe-depth	Severe-depth	Severe-depth	Severe-depth	Severe-depth	Severe-depth	Fair A-4	Poor shallow loamy sand	Unsuited	Poor shallow loamy sand	Poor shallow loamy sand	Poor shallow	shallow, rapid permeability	shallow, medium to high susceptibility to piping
M	Severe-moderately slow permeability	Severe-moderately slow permeability	Moderate-moderately slow permeability	Moderate-moderately slow permeability	Slight	Moderate-moderate shrink-swell	Moderate-moderate shrink-swell	Fair to poor A-4 A-6	Unsuited silty clay loam	Unsuited	Poor alkali salts	Poor alkali salts	Poor alkali salts	slow permeability, deep	medium to low shear strength
W	Severe-seasonal high water table Flood danger	Severe-seasonal high water table. Flood danger	Severe-seasonal high water table. Flood danger	Severe-seasonal high water table. Flood danger	Moderate-seasonal high water table. Flood danger	Severe-flood danger. Season high water table.	Severe-flood danger Season high water table.	Fair to poor A-4 A-6	Poor silt loam Inclusive of fine sand	Unsuited	Good silt loam poor fine sand	Good	Fair high salt content in subsoil	high water table	low to high susceptibility to piping, medium to low shear strength

The A, As, B, Bs, and F soils all have severe limitations, mainly because of steep slopes and shallow to very shallow soil mantles over bedrock. The Ds and E soils have slight limitations for most uses but have moderate limitations for sewage lagoons because of the 5 percent to 10 percent slopes. Because of the moderately slow permeability, N soils have severe limitations for septic tank drainage fields and sewage lagoons; the limitations for other uses are mainly moderate. The W soils mainly have severe limitations because of seasonal high water table and flood danger.

Soils were rated for their suitability as a source of roadfill, sand, gravel, topsoil, sanitary landfill cover material, and spent-shale cover material.

The suitability was rated in terms of "good," "fair," and "poor," which parallel the limitation terms "slight," "moderate," and "severe." Most of the soils have a good to fair rating for roadfill material, based on AASHO test data. The exceptions are the N and W soils, which have fair to poor ratings. The soils were rated poor for sand or gravel.

The soils were rated poor for topsoil and as cover for sanitary landfill and spent-shale deposits if they were high in coarse fragments (channers and flaggs), shallow or very shallow to bedrock, and if they were moderately fine textured and contained alkali and salts. It should be noted that the soluble salt content increases markedly in the deeper subsoils; the upper 50 cm to 80 cm (20 in. to 31 in.) is usually best suited as a source of topsoil. The A, As, B, Bs, F, and N soils were rated poor, and the Ds, E, and W were rated fair to good. The D and W soils are the best material for these uses, especially as cover for spent shale. The Southam Canyon area, where the spent shale will likely be deposited, contains about 259 ha (640 acres) of D soils. The W soils along the White River Valley contain some salt and would require transporting some distance to the spent shale site. The suitable E soils would be good for all these uses, but they would be difficult to separate from the unsuitable N soils.

The soil features that affect their use are shown on Table V-7. Depth, slope, permeability, and water table affect their use in pond-reservoir areas. Depth, stoney material, susceptibility to piping, and shear strength affect their use for dams, levees, and other embankment materials. The N and E soils occur in complex in the mapping units on the river terraces above the present flood plain of the White River. The moderately fine textured N soil is a possible source of material for dam construction. The thickness of the material is about 76 cm (30 in.).

The deep soils on the tracts and the 1.6 km (1-mi) perimeter total 1,660 ha (4,100 acres), or approximately 15 percent of the area. The deep soils are D, 850 ha (2,100 acres); NE, 120 ha (300 acres); EN, 110 ha (270 acres) and W, 460 ha (1,140 acres).

g. Soil Infiltration

The soil infiltration study was conducted to generate base-line data for evaluating how the soils will be impacted by land-use changes. These data will also be used with the soils map to estimate runoff volumes by applying the U. S. Soil Conservation Service runoff calculations.

A Rocky Mountain infiltrometer was used to generate runoff from 96 small, movable 76 cm by 30 cm plots (0.23 sq m of soil surface coverage). The soils of most limited extent were not tested. Plots were installed by driving the edges 9 cm (3.5 in) into the soil surface with a specially constructed hammer. An adjustable canvas wind shield was used to prevent wind disturbance and raindrop drift. Plots were pre-wet to field capacity (called "wet plots") prior to an infiltrometer run. Artificial rainfall was applied to the plots at rates of 10 cm to 15 cm (4 in. to 6 in.) per hr for 28 min. Rainfall and runoff rates were determined at 5-min intervals, and infiltration was the difference between these two measurements. Sediment-yield values were also obtained. All samples were taken during October 1974 and October 1975. Sample points are shown on Figure V-2.

Several limitations of these data must be considered. The principal limitation is the difficulty in simulating natural conditions with a small infiltration-test device and the few sites tested. Also, seasonal variations in soil infiltration rates were not tested. The data provided is best used to compare soil types.

Infiltration rates for wet soils are shown in Table V-8. Upland soils have rates of about 3.6 cm (1.4 in.) per hr. The soils of the bottomlands (D soils) have greater rates--about 6.1 cm (2.4 in.) per hour. The soils formed on the alluvium of the White River (W soils) have much slower rates of uptake--about 1.5 cm (0.6 in.) per hr. As expected, soils affected by excess sodium (N soils) have the lowest infiltration rates of all the soils tested--about 0.8 cm (0.3 in.) per hr.

Infiltration rates did not decrease significantly during the 28-min period of the test; in fact, most runs showed no time trend. Runs that did decrease with time had small magnitudes, approximately 1.3 cm (0.5 in.) per hr, and were only apparent for the first 5 min of the run. In addition, soil type was apparently more significant than slope angle in determining infiltration rates. For these reasons, infiltration data can be best summarized as a mean infiltration rate in each soil type.

The rate of application was high to simulate severe storms. Because infiltration rates tend to be lowest in the fall and because the applied rates were high, runoff values should be maximum.

Curve-number means and sediment-yield rates are also shown in Table V-8. The curve numbers can be used to calculate runoff using the SCS method. Since the rates are highly variable, the standard deviations are large. The estimates of sediment yield are used primarily to compare soils.

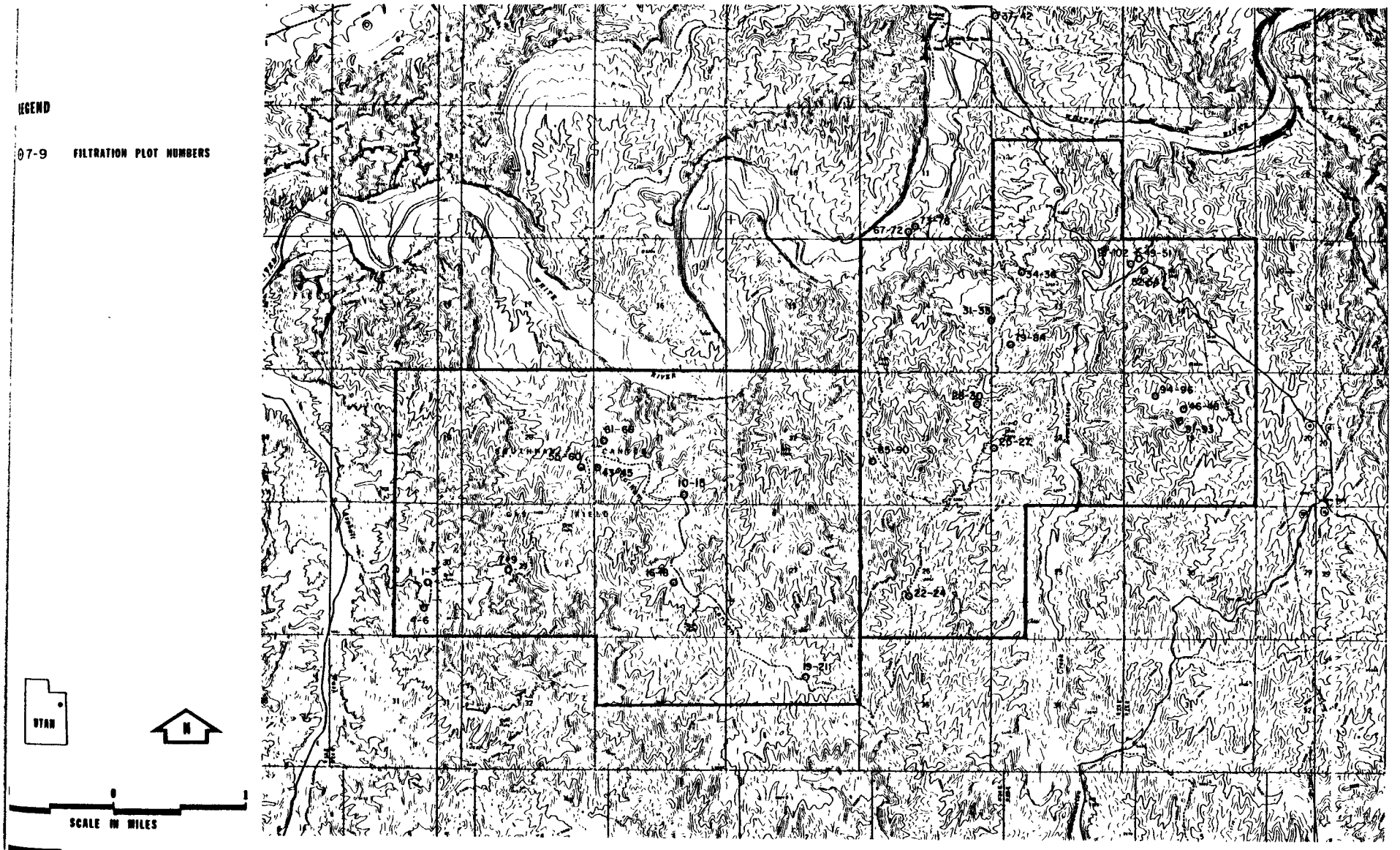
A few sites were not wetted before testing. These dry sites provided some information on the infiltration rates of soils with little antecedent moisture. The infiltration rates of dry soils were a fraction of an inch per hour slower than those of wet soils on the same plots.

Infiltration rates, curve numbers, and sediment yields for all 96 plots are contained in Appendix V-2.

h. Soil Radioactivity

The soils were measured to establish baseline levels of radioactivity in the area and to separate the sources from (1) radioactivities originating from nuclides within the oil shale (usually from nuclides in a uranium decay chain, which could affect the environment); (2) naturally occurring background activity; and (3) radioactivity identified with the worldwide fallout from weapons testing. The radiation levels in tract soils are primarily associated with naturally occurring background activity.

A number of soil samples were collected from representative locations on the two lease tracts and analyzed for radioactivity. No sources above a normal background level were identified, with Ra^{226} activity below 0.87 pCi/g, Sr^{90} below 0.52 pCi/g; K^{40} below 20.0 pCi/g, Pb^{212} below 1.5 pCi/g, Cs^{137} below 1.6 pCi/g recorded for all samples. Detailed results of the soil radioactivity tests are contained in Appendix V-3.



LOCATIONS OF SOIL INFILTRATION PLOTS

FIGURE V-2

TABLE V-8

SUMMARY OF SOIL INFILTRATION RATES

	Mean Infiltration (in./hr)	±1 Std. Dev.	Mean Curve Number	±1 Std. Dev.	Mean Sediment Yield (tons/acre)	±1 Std. Dev.
D_S (wet)	2.4	0.75	86	9.80	0.3	0.25
B_S (wet)	1.5	0.70	92	3.03	0.6	1.02
A (wet)	1.3	0.41	94	2.15	0.2	0.31
A_S (wet)	1.0	0.58	96	1.64	0.1	0.07
W (wet)	0.6	0.46	97	1.51	0.1	0.05
N (wet)	0.3	0.29	98	1.22	0.2	0.13
F (wet)	1.9	0.46	89	4.36	0.1	0.01
E (wet)	1.8	0.75	90	5.08	0.1	0.03
B (wet)	0.5	0.39	96	1.73	0.1	0.05
D_S (dry)	2.4	0.74	89	6.49	0.2	0.09
B_S (dry)	2.8	0.51	86	0.57	0.5	0.23

SOURCE: VTN

To convert from tons/acre to kilograms/hectare multiply by 2242.

i. Relationship Between Soils and Vegetation

Plant available moisture is the most important factor in determining the distribution of vegetation types in the arid west. Soil characteristics are one of the important factors that determine plant available moisture. As a result, distribution of vegetation types often correspond to the distribution of soil types. At the site, where vegetation pattern and soil type distribution coincide, it is usually a function of soil moisture.

Greasewood vegetation occurs exclusively on the D soils at the site. D soils are the deep, sandy loam soils forming in alluvium. They occur in the relatively narrow drainages below steeply sloping soils and rock outcrops. The soil has a relatively high water holding capacity. The correlation between areas of D soil and areas of greasewood vegetation is the closest of any of the soil-vegetation relationships at the site.

Riparian vegetation, as the name implies, is only found in areas adjacent to water and on moist soils. The soils of the site that are moist enough to sustain this type of vegetation are W soils and D soils. The W soils are deep, imperfectly drained, and form in silty alluvium adjacent to the flood plain of the White River. All of the W soil mapped at the site support riparian vegetation. Riparian vegetation also occurs along Evacuation Creek where D soils are moist enough.

The upland soils at the site are similar to one another, but support a variety of vegetation types. The juniper are found at the higher elevations on the thin sandy soils; As, Bs, and F. These are shallow and very shallow sands, sandy loams or loams. The eastern limits of juniper roughly coincide with the limits of these soils along the west side of Evacuation Creek. However, the same soils extend beyond the limits of the juniper because the juniper are limited by their altitudinal requirements. The thin sandy soils that are below the juniper limits to the north and to the west are dominated by big sagebrush.

The soils that have formed on the Green River Formation are the A and B soils, which are very shallow loam soils. These soils are less sandy than the upland soils found on the Uinta Formation. The vegetation on these soils is exclusively the shadscale-black sagebrush type. The shadscale-blacksage type is not limited to soils A and B, however, but also dominates on the sandy soils (As, Bs and F) that occur north of the White River.

4. CONCLUSIONS

The soils of Tracts U-a and U-b are mainly shallow to very shallow (less than 50 cm (20 in.) deep) soils on sloping to steep upland surfaces cut by numerous intermittent drainages and containing many areas of rock outcrop and rock escarpments.

Soils A, As, B, Bs, and F are included in these shallow sites. They consist of sandy loam, loams, channery sandy loams, and channery loams. The coarse-fragment content (channers and flaggs) usually increases with depth, and numerous flagstones with a small proportion of soil occurs immediately above the bedrock. Surface soils are light colored and moderately calcareous. The $CaCO_3$ (lime) content usually increases with depth and occurs as a coating on the undersides of rock fragments.

There are numerous drainageways throughout the tracts. Most of them have intermittent stream channels, and the soils--usually Ds soils--along these channels are generally deep (more than 150 cm (59 in.)), mainly sandy loams or channery sandy loams, light colored, and moderately calcareous. They are the most extensive in the Southam Canyon drainage area.

Along the Evacuation Creek drainage the Ds soils are associated with N soils. The N soils are deep and moderately fine textured and are strongly alkaline with a high concentration of exchangeable sodium. The N soils also occur on stream terraces about 15 m to 30 m (50 ft to 100 ft) above the White River flood plain. In these areas the N soils occur with E soils, which are deep and moderately coarse textured, with a strong $CaCO_3$ (lime) horizon in the subsoil.

The W soils occur adjacent to the White River, mainly in the corridor outside the tracts. They are deep and silty and seasonally wet in the deeper horizons. They generally have a high salt content.

Infiltration rates vary with the soil type. The upland soils (A, As, B, Bs, F) have rates of about 3.6 cm (1.4 in.) per hr. The soils bottomlands (D) have greater rates--about 6.1 cm (2.4 in.) per hr. The soils formed on the alluvium of the White River (W soils) have much slower rates of uptake--about 1.5 cm (0.6 in.) per hr. As expected, soils affected by excess sodium (N soils) have the lowest infiltration rates of all the soils tested--about 0.8 cm (0.3 in.) per hr.

The soils were measured for radioactivity. No sources above a normal background level were identified.

5. WORK SCHEDULED

The soils survey program is complete. Potentially deleterious elements in the soils will be determined.

UTAH STATE UNIVERSITY
Soils Laboratory
Logan, Utah

SOIL ANALYSIS REPORT

Project: Dr. A. R. Southard DATE _____ LOCATION Oil Shale Ua and Ub

Soil	Laboratory Number	Collector number	Depth cm	Horizon	Particle size distribution (in mm) (percent) Very coarse sand 2-1	Coarse sand 1-0.5	Medium sand 0.5-0.25	Fine sand 0.25-0.10	Very fine sand 0.10-0.05	% Silt – Hydrometer –	% Clay – Hydrometer –	% Sand – Hydrometer –	% > 2 mm.	Textural class
A	36	22	0-9		13	7	3	5	1	49	16	35	29	L
	37		9-25		12	7	3	7	12	50	15	35	39	L
	38		25-36		17	10	6	12	14	39	16	45	59	L
	39		36-46		28	16	8	10	5	29	13	58	57	SL
B -	40	63	0-8		9	8	7	17	11	38	20	42	44	L
Bs	41		8-14		7	4	3	7	8	55	21	24	40	SiL
	42		14-27		6	3	1	5	11	60	25	15	52	SiL

Soil	Laboratory Number	pH Saturated paste	pH 1:5	Organic matter %	Organic carbon %	Nitrogen %	C/N	Total soluble salts %	Electrical conductivity EC x 10³ millimhos per cm @ 25°C	$CaCO_3$ equivalent per cent	Gypsum me./100g soil	Gypsum %	Moisture tensions 1/3 atmos. %	Moisture tensions 15 atmos. %
A	36	7.5			1.8				.7	32.1			19.4	8.8
	37	7.6			1.8				.6	42.6			22.9	12.4
	38	7.8			2.6				.5	52.0			27.1	17.0
	39	7.9			.9				.5	52.0			20.2	6.6
Bs	40	8.0			.5				.7	7.2			17.3	8.0
	41	7.5			.7				1.7	11.4			23.5	10.2
	42	8.3			.5				2.5	14.2			25.2	10.1

Soil	Laboratory Number	Cation exchange capacity	Extractable cations Ca	Mg	Na	K	Available P ppm	Saturation extract soluble Na	K	CO_3	HCO_3	Cl	SO_4	Per cent moisture at saturation
			NH_4OAc me/100g					milliequivalents per liter						
A	36			3.1	.6	.6	7.9							44
	37			4.4	.4	.2	1.9							54
	38			5.7	.5	.1	3.4							70
	39			4.4	.3	<.1	1.4							34
Bs	40			1.5	.9	.2	4.9							28
	41			3.3	5.8	.2	2.1							42
	42			3.5	10.9	.2	.5							44

UTAH STATE UNIVERSITY
Soils Laboratory
Logan, Utah
SOIL ANALYSIS REPORT

Collected by Dr. A. Southard DATE _____ LOCATION Oil Shale Ua and Ub

Soil	Laboratory No.	Collector's No.	Depth in cm.	Horizon	Particle Size Distribution (in mm.) (percent): Very Coarse Sand 2-1	Coarse Sand 1-0.5	Medium Sand 0.5-0.25	Fine Sand 0.25-0.10	Very Fine Sand 0.10-0.05	% Silt – Hydrometer	% Clay – Hydrometer	% Sand – Hydrometer	% < 2 mm	Textural Class
As	2	37-0-8			11	10	9	24	14	27	11	62	16	SL
	3	8-22			14	9	6	20	15	29	10	61	47	SL
	4	22-36			12	6	3	10	15	45	12	43	39	L
	1	36-44			insuff. sample								57	—
As	5	38 0-12			8	8	11	27	9	28	10	62	28	SL
	6	12-27			8	5	3	6	10	57	9	34	37	SiL
	7	27-53			16	9	6	12	9	46	9	45	21	L

Soil	Laboratory No.	pH Saturated Paste	pH 1:5	Organic Matter: Organic Matter %	Organic Carbon %	Nitrogen %	C/N	Total Soluble Salts %	Electrical Conductivity EC x 10^3 Millimhos per cm @ 25°C	$CaCO_3$ equivalent per cent	Gypsum: me /100_g Soil	Gypsum %	Moisture Tensions: 1/3 Atmos. %	15 Atmos. %
As	2	8.1			.9				.5	11.3			12.9	6.1
	3	8.5			.8				.9	11.1			16.5	8.3
	4	8.4			.8				5.8	10.8			24.3	8.2
	1	8.4			.6				20	8.3			insuf. sample	
As	5	8.1			2.4				.6	14.8			18.3	11.4
	6	8.5			1.1				.3	23.5			31.6	9.4
	7	8.5			.6				.5	41.3			19.4	6.4

Soil	Laboratory No.	Cation Exchange Capacity	Extractable Cations ppm (NH_4OAc): Ca	Mg	Na	K	Available P ppm	Saturation Extract Soluble (milliequivalents per liter): Na	K	CO_3	HCO_3	Cl	SO_4	Per Cent Moisture at Saturation
As	2			1.4	.4	.4	5.7							30
	3			2.4	1.4	.1	.9							42
	4			3.9	9.4	.1	.3							44
	1			5.7	12.5	.1	1.4							41
As	5			1.0	.4	.2	4.0							49
	6			2.6	.7	.1	.3							58
	7			3.5	.7	<.1	.3							41

UTAH STATE UNIVERSITY

Soils Laboratory

Logan, Utah

SOIL ANALYSIS REPORT

COLLECTED BY Dr. A. Southard DATE _____ LOCATION _____

Soil	Laboratory Number	Collector's Number	Depth cm.	Horizon	Particle Size Distribution (in mm.) (percent) Very Coarse Sand 2-1	Coarse Sand 1-0.5	Medium Sand 0.5-0.25	Fine Sand 0.25-0.10	Very Fine Sand 0.10-0.05	% Silt – Hydrometer	% Clay – Hydrometer	% Sand – Hydrometer	% > 2 mm	Textural Class
F	8	#39	0-4		2	11	30	29	8	9	8	83	4	LS
	9		4-17		6	13	30	25	6	11	11	78	7	SL
	10		17-35		11	19	27	21	5	8	10	82	25	LS
Ds	11	#40	0-6		7	9	15	27	12	22	12	66	18	SL
	12		6-31		11	10	13	23	12	24	9	67	21	SL
	13		31-137		12	12	14	23	11	21	9	70	23	SL

Soil	Laboratory Number	pH Saturated Paste	pH 1:5	Organic Matter: Organic Matter %	Organic Carbon %	Nitrogen %	C/N	Total Soluble Salts %	Electrical Conductivity EC x 10^3 Millimhos per cm @25°C	$CaCO_3$ equivalent per cent	Gypsum me./100g soil	Gypsum %	Moisture Tensions 1/3 Atmos. %	Moisture Tensions 15 Atmos. %
F	8	8.1			.5				.6	3.0			8.1	4.6
	9	8.2			.5				.5	3.7			9.3	5.8
	10	8.5			.5				.3	6.8			10.4	6.3
Ds	11	8.0			.9				.9	13.4			13.9	6.0
	12	8.3			.5				.4	9.7			11.9	5.7
	13	8.2			.5				1.9	7.8			12.9	6.2

Soil	Laboratory Number	Cation Exchange Capacity	Extractable Cations ppm (NH_4OAc) Ca	Mg	Na	K	Avail P ppm	Saturation Extract Soluble (milliequivalents per liter) Na	K	CO_3	HCO_3	Cl	SO_4	Per Cent Moisture at Saturation
F	8			1.0	.3	.4	16							29
	9			1.3	.5	.2	3.2							32
	10			1.0	.5	<.1	1.0							38
Ds	11			1.9	.4	1.1	24							34
	12			1.9	.4	.7	4.9							32
	13			2.3	2.8	.2	3.5							33

UTAH STATE UNIVERSITY
Soils Laboratory
Logan, Utah
SOIL ANALYSIS REPORT

COLLECTED BY Dr. A. Southard DATE _____ LOCATION Oil Shale Ua and Ub

Soil	LAB. NO.	COLLECTOR NO.	DEPTH IN cm.	HORIZON	PARTICLE SIZE DISTRIBUTION (in mm) (percent) VERY COARSE SAND 2-1	COARSE SAND 1-0.5	MEDIUM SAND 0.5-0.25	FINE SAND 0.25-0.10	VERY FINE SAND 0.10-0.05	% SILT	% CLAY	% Sand	% >2 mm.	TEXTURAL CLASS
										– Hydrometer –				
Aa As	14	P42	0-6		9	16	15	19	8	23	10	67	29	SL
	15		6-13		10	15	14	20	9	28	10	62	27	SL
	16		13-41		15	10	8	17	9	36	10	54	31	SL
	17		41-60		14	9	5	13	14	40	13	47	28	L
Ab Ds	18	P45	0-4		8	7	9	22	13	31	12	57	22	SL
	19		4-23		9	10	12	26	12	25	12	63	31	SL
	20		23-40		7	9	11	24	12	26	11	63	18	SL
	21		40-76		7	7	9	22	13	26	13	61	18	SL
	22		76-121		11	13	13	21	8	20	13	67	41	SL

Soil	LAB. NO.	SATURATED PASTE pH	1:5 pH	ORGANIC MATTER: ORGANIC MATTER %	ORGANIC CARBON %	NITROGEN %	C/N	TOTAL SOLUBLE SALTS %	ELECTRICAL CONDUCTIVITY EC x 10^3 MILLIMHOS PER CM @ 25°C	$CaCO_3$ equivalent per cent	GYPSUM: me/100g SOIL	GYPSUM: %	MOISTURE TENSIONS: 1/3 ATMOS. %	MOISTURE TENSIONS: 15 ATMOS. %
Aa As	14	8.1			1.5				.5	7.4			15.0	8.0
	15	8.1			2.4				.3	10.7			20.6	12.7
	16	8.5			1.2				.4	13.6			20.3	8.7
	17	8.6			.8				1.9	12.6			21.3	8.9
Ab Ds	18	7.9			.8				.4	6.0			13.8	6.2
	19	8.2			1.0				.3	8.1			12.9	7.2
	20	8.3			.6				2.4	8.3			13.8	7.5
	21	8.2			.4				13.0	7.6			14.9	7.8
	22	8.3			.2				19.0	9.7			13.7	7.1

Soil	LAB. NO.	CATION EXCHANGE CAPACITY	Extractable CATIONS ppm (NH4OAc): Ca	Mg	Na	K	Available P ppm	SATURATION EXTRACT SOLUBLE (milliequivalents per liter): Na	K	CO_3	HCO_3	Cl	SO_4	PER CENT MOISTURE AT SATURATION
As	14			.8	.3	.2	3.8							38
	15			1.0	.4	.1	2.2							58
	16			2.7	1.0	.1	.5							52
	17			5.2	6.4	.1	.3							51
Ds	18			.7	.3	.4	3.3							29
	19			1.2	.4	.2	1.0							41
	20			2.0	3.3	.1	.3							34
	21			2.4	9.7	.1	.3							35
	22			2.9	14.0	.1	1.5							33

R E Fenton

UTAH STATE UNIVERSITY
Soils Laboratory
Logan, Utah
SOIL ANALYSIS REPORT

COLLECTED BY Dr. A. Southard DATE _____ LOCATION Oil Shale Ua and Ub

Soil	Laboratory Number	Collector's Number	Depth in cm.	Horizon	Particle Size Distribution (in mm.) (percent) Very Coarse Sand 2-1	Coarse Sand 1-0.5	Medium Sand 0.5-0.25	Fine Sand 0.25-0.10	Very Fine Sand 0.10-0.05	% Silt (Hydrometer)	% Clay (Hydrometer)	% Sand (Hydrometer)	% > 2 mm	Textural Class
A	23	#46	0-6		18	9	4	8	11	40	13	47	23	L
	24		6-20		12	7	3	5	6	62	13	25	35	SiL
	25		20-45		12	7	3	5	6	59	14	27	34	SiL
N	26	#48	0-9		1	1	3	16	33	33	10	57	1	SL
	27		9-20		<1	1	2	12	26	34	27	39	1	L
	28		20-34		<1	1	2	8	15	35	38	27	0	CL
	29		34-55		<1	1	3	12	16	35	31	34	1	CL
	30		55-89		<1	1	2	7	21	40	30	30	0	CL
	31		89-158		1	2	2	8	17	46	26	28	2	L

Soil	Laboratory Number	pH Saturated Paste	pH 1:5	Organic Matter: Organic Matter %	Organic Carbon %	Nitrogen %	C/N	Total Soluble Salts %	Electrical Conductivity EC x 10^3 Millimhos per cm @25°C	$CaCO_3$ equivalent per cent	Gypsum me./100g soil	Gypsum %	Moisture Tensions 1/3 Atmos. %	Moisture Tensions 15 Atmos. %
A	23	8.0			1.1				.5	8.3			20.1	7.3
	24	8.3			1.2				.4	23.4			28.9	9.6
	25	8.7			1.0				1.1	16.4			32.5	9.1
N	26	8.7			.3				.9	4.5			9.8	3.6
	27	8.9			.3				2.4	10.5			26.4	11.3
	28	8.5			.3				14.0	15.2			26.8	14.0
	29	8.2			.2				33.0	15.5			20.2	10.5
	30	8.1			.2				22.0	15.4			18.9	8.3
	31	8.3			.1				20.0	11.7			18.9	8.3

Soil	Laboratory Number	Extractable Cations ppm: Cation Exchange Capacity	Ca	Mg	Na	K	Available P ppm	Saturation Extract Soluble: Na	K	CO_3	HCO_3	Cl	SO_4	% Moist. at Sat.
			NH_4OAc					milliequivalents per liter						
A	23			2.2	.4	.3	7.3							39
	24			5.0	.9	.1	1.5							56
	25			8.6	3.0	.1	1.5							57
N	26			2.4	1.7	.9	6.4							28
	27			3.9	11.4	.3	3.4							48
	28			5.7	19.8	.2	1.8							62
	29			5.7	19.6	.2	1.0							48
	30			5.0	15.7	.1	1.0							48
	31			5.0	13.5	.2	.6							49

UTAH STATE UNIVERSITY
Soils Laboratory
Logan, Utah
SOIL ANALYSIS REPORT

COLLECTED BY Dr. A. Southard DATE _____ LOCATION Oil Shale Ua and Ub

Soil	Laboratory Number	Collector's Number	Depth in cm.	Horizon	Particle Size Distribution (in mm.) (percent): Very Coarse Sand 2-1	Coarse Sand 1-0.5	Medium Sand 0.5-0.25	Fine Sand 0.25-0.10	Very Fine Sand 0.10-0.05	% Silt (Hydrometer)	% Clay (Hydrometer)	% Sand (Hydrometer)	% > 2 mm.	Textural Class
A	32	#50	0-11		4	3	2	10	18	44	16	40	21	L
	33		11-30		12	6	3	10	13	44	15	41	41	L
	34		30-42		21	13	6	11	8	35	14	51	60	L
	35		42-49		23	14	6	16	7	27	17	56	57	SL

Soil	Laboratory Number	pH: Saturated Paste	pH: 1:5	Organic Matter: Organic Matter %	Organic Matter: Organic Carbon %	Organic Matter: Nitrogen %	Organic Matter: C/N	Total Soluble Salts %	Electrical Conductivity EC x 10³ Millimhos per cm. @ 25°C	$CaCO_3$ equivalent per cent	Gypsum: me./100g soil	Gypsum: %	Moisture Tension: 1/3 Atmos. %	Moisture Tension: 15 Atmos. %
A	32	8.0			1.1				.8	3.9			19.4	9.4
	33	8.2			1.1				.4	15.9			20.7	9.8
	34	9.0			.8				1.1	10.9			26.1	11.2
	35	8.5			.7				5.4	8.5			24.2	11.4

Soil	Laboratory Number	Cation Exchange Capacity	Extractable Cations ppm (NH_4OAc): Ca	Mg	Na	K	Available P ppm	Saturation Extract Soluble (milliequivalents per liter): Na	K	CO_3	HCO_3	Cl	SO_4	Per Cent Moisture at Saturation
A	32			2.9	1.0	.8	7.4							36
	33			2.9	1.4	.1	1.1							56
	34			2.6	10.9	.8	1.0							46
	35			3.5	13.5	.2	3.5							46

UTAH STATE UNIVERSITY

Soils Laboratory

Logan, Utah

SOIL ANALYSIS REPORT

COLLECTED BY Dr. A. R. Southard DATE _____ LOCATION Oil Shale IIa and IIb

Soil	Laboratory Number	Collector's Number	Depth in cm.	Horizon	Particle Size Distribution (in mm) (percent) Very Coarse Sand 2-1	Coarse Sand 1-0.5	Medium Sand 0.5-0.25	Fine Sand 0.25-0.10	Very Fine Sand 0.10-0.05	% Silt (Hydrometer)	% Clay (Hydrometer)	% Sand (Hydrometer)	% > 2 mm.	Textural Class
As	52	53	0-8		14	8	6	14	14	31	13	56	32	SL
	53		8-23		10	7	4	11	11	46	10	44	26	L
	54		23-45		11	7	4	11	13	52	10	38	35	SiL
Ds	55	58	0-10		1	2	5	34	24	29	10	61	2	SL
	56		10-34		6	9	16	35	12	14	10	76	6	SL
	57		34-72		12	15	20	29	7	10	6	84	38	LS
	58		72-127		23	14	13	20	8	14	9	77	61	SL

Soil	Laboratory Number	pH Saturated Paste	pH 1:5	Organic Matter %	Organic Carbon %	Nitrogen %	C/N	Total Soluble Salts %	Electrical Conductivity EC x 10^3 Millimhos per cm @ 25°C	$CaCO_3$ equivalent per cent	Gypsum me./100g Soil	Gypsum %	Moisture Tensions 1/3 Atmos. %	Moisture Tensions 15 Atmos. %
As	52	7.9			1.5				.5	4.9			17.4	9.7
	53	7.8			1.8				.5	13.4			24.8	12.4
	54	8.7			.7				2.5	12.4			27.6	13.3
Ds	55	9.9			.5				5.0	6.2			11.3	5.8
	56	10.4			.3				12.0	5.7			8.7	6.6
	57	8.0			.3				15.0	5.3			7.6	6.0
	58	8.0			.2				3.5	14.6			10.8	5.8

Soil	Laboratory Number	Cation Exchange Capacity	Extractable Cations Ca	Mg	Na	K	Available P ppm	Saturation Extract Soluble Na	K	CO_3	HCO_3	Cl	SO_4	Per Cent Moisture at Saturation
		NH_4OAc me/100g						millieq/liter						
As	52			.6	.4	.4	11							41
	53			.7	.9	.1	1.4							58
	54			1.1	8.4	.1	.6							56
Ds	55			1.2	6.9	1.3	8.9							41
	56			.4	10.3	.3	10.9							30
	57			.9	3.1	.1	2.1							26
	58			1.5	1.4	.1	1.8							28

UTAH STATE UNIVERSITY
Soils Laboratory
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SOIL ANALYSIS REPORT

COLLECTED BY Dr. A. R. Southard DATE _____ LOCATION Oil Shale Ua and Ub

Soil	Laboratory Number	Collector's Number	Depth in cm.	Horizon	Particle Size Distribution (in mm.) (percent): Very Coarse Sand 2-1	Coarse Sand 1-0.5	Medium Sand 0.5-0.25	Fine Sand 0.25-0.10	Very Fine Sand 0.10-0.05	% Silt - Hydrometer -	% Clay	% Sand	% >2 mm	Textural Class
E	43	55	0-5		3	1	2	14	41	31	9	60	4	SL
	44		5-15		2	2	3	12	35	35	10	55	3	SL
	45		15-40		3	2	3	12	31	39	10	51	5	L
	46		40-120		3	4	4	14	25	38	10	52	6	SL
	47		120-160		3	4	6	16	21	34	12	54	9	SL
A	48	54	0-8		8	5	6	20	17	29	13	58	20	SL
	49		8-17		8	5	6	22	18	29	13	58	16	SL
	50		17-30		16	8	6	15	10	27	19	54	38	SL
	51		30-33		22	13	5	8	5	33	20	47	38	L

Soil	Laboratory Number	pH: Saturated Paste	pH: 1:5	Organic Matter: Organic Matter %	Organic Carbon %	Nitrogen %	C/N	Total Soluble Salts %	Electrical Conductivity EC x 10^3 Millimhos per cm @ 25°C	$CaCO_3$ equivalent per cent	Gypsum: me/100g Soil	Gypsum: %	Moisture Tensions: 1/3 Atmos. %	Moisture Tensions: 15 Atmos. %
E	43	7.7			.7				.8	2.9			10.0	4.8
	44	7.8			.4				.6	3.1			11.0	5.5
	45	7.8			.3				.4	4.9			12.4	5.9
	46	8.0			.4				.8	4.9			13.5	6.3
	47	7.7			.3				16.0	6.0			14.6	6.4
A	48	7.9			.8				.5	6.8			15.0	7.5
	49	7.9			.7				.3	9.3			17.2	9.2
	50	7.9			.8				.3	11.5			20.4	12.0
	51	8.0			.8				.4	7.3			21.0	11.1

Soil	Laboratory Number	Cation Exchange Capacity	Extractable Cations: Ca	Mg	Na	K	Available P ppm	Saturation Extract Soluble: Na	K	CO_3	HCO_3	Cl	SO_4	Per Cent Moisture at Saturation
			NH_4OAc me/100g					millieqivalents per liter						
E	43			2.7	.3	1.4	24							33
	44			2.5	.3	.5	2.6							28
	45			2.7	.4	.2	1.8							33
	46			3.4	1.1	.2	1.9							35
	47			4.4	6.7	.3	9.2							34
A	48			10.4	.3	.4	7.1							29
	49			1.5	.3	.1	.6							39
	50			1.9	.5	.1	.5							42
	51			1.9	.8	.1	.6							41

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Soil	Laboratory Number	Collector's Number	Depth in cm.	Horizon	Particle Size Distribution (in mm.) (percent): Very Coarse Sand 2-1	Coarse Sand 1-0.5	Medium Sand 0.5-0.25	Fine Sand 0.25-0.10	Very Fine Sand 0.10-0.05	% Silt – Hydrometer –	% Clay – Hydrometer –	% Sand – Hydrometer –	% > 2 mm.	Textural Class
Ds	1	#64	0-10		9	9	11	21	11	27	11	62	13	SL
	2		10-40		14	14	14	23	9	19	11	70	24	SL
	3		40-65		12	14	13	20	9	23	12	65	20	SL
	4		65-113		11	16	15	21	9	21	11	68	15	SL
	5		113-150		12	12	13	22	11	23	10	67	21	SL
As	6	#66	0-5		8	10	15	27	9	24	11	65	20	SL
	7		5-15		7	10	14	28	10	21	10	69	40	SL
	8		15-30		13	11	12	30	9	19	13	68	52	SL

Soil	Laboratory Number	pH: Saturated Paste	pH: 1:5	Organic Matter: Organic Matter %	Organic Matter: Organic Carbon %	Organic Matter: Nitrogen %	Organic Matter: C/N	Total Soluble Salts %	Electrical Conductivity EC x 10^3 Millimhos per cm @ 25°C	$CaCO_3$ equivalent per cent	Gypsum: me/100g soil	Gypsum: %	Moisture Tensions: 1/3 Atmos. %	Moisture Tensions: 15 Atmos. %	Liquid Limit %
Ds	1	8.1			1.1				.6	5.8			14.2	6.0	23
	2	8.1			.5				.4	5.9			11.8	5.6	21
	3	8.1			.4				.6	9.2			12.4	6.2	21
	4	8.1			.4				2.6	7.5			11.6	5.8	21
	5	8.1			.3				28.0	7.2			13.7	6.0	20
As	6	8.1			1.1				.5	12.6			14.1	6.7	24
	7	8.1			1.4				.4	9.8			15.2	7.5	28
	8	8.0			1.8				.4	17.8			20.3	11.4	36

Soil	Laboratory Number	Extractable Cations: Cation Exchange Capacity	Ca	Mg	Na	K	Available P ppm	Saturation Extract Soluble: Na	K	CO_3	HCO_3	Cl	SO_4	Per Cent Moisture at Saturation	Plastic Index %
		NH_4OAc me/100g						millieq. per liter							
Ds	1			1.1	.3	.3	17							32	NP
	2			.9	.5	.1	3.6							30	NP
	3			.5	.8	.1	3.7							31	NP
	4			.9	3.8	.1	4.1							33	NP
	5			1.5	12.9	.2	2.4							29	NP
As	6			.5	.4	.2	2.6							38	NP
	7			.7	.4	.1	1.2							46	NP
	8			.8	.4	.1	1.5							50	NP

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Soil		LABORATORY NUMBER	COLLECTOR'S NUMBER	DEPTH in cm.	HORIZON	PARTICLE SIZE DISTRIBUTION (in mm.) (percent) VERY COARSE SAND 2-1	COARSE SAND 1-0.5	MEDIUM SAND 0.5-0.25	FINE SAND 0.25-0.10	VERY FINE SAND 0.10-0.05	SILT - Hydrometer -	CLAY	% Sand	% > 2 mm.	TEXTURAL CLASS
As	9		#67	0-5		10	9	12	19	9	27	14	59	39	SL
	10			5-12		13	8	8	20	15	28	15	57	60	SL
	11			12-25		14	9	7	16	12	34	14	52	67	SL
	12			25-35		18	12	8	20	11	22	13	65	63	SL
	13		#68	0-8		7	4	4	15	18	38	14	48	28	L
A	14			8-20		10	6	4	13	12	40	20	40	55	L
	15			20-33		22	11	5	8	7	35	17	48	44	L
	16			33-50		17	10	6	13	10	36	17	47	77	L

Soil		pH SATURATED PASTE	pH 1:5	ORGANIC MATTER ORGANIC MATTER %	ORGANIC CARBON %	NITROGEN %	C/N	TOTAL SOLUBLE SALTS %	ELECTRICAL CONDUCTIVITY EC x 10³ MILLIMHOS PER CM @ 25°C	$CaCO_3$ equivalent per cent	GYPSUM me./100g SOIL	GYPSUM %	MOISTURE TENSIONS 1/3 ATMOS %	MOISTURE TENSIONS 15 ATMOS. %	Liquid Limit %
As	9	8.0			1.4				.5	7.0			17.7	8.1	27
	10	8.2			1.5				.6	8.6			21.2	9.9	37
	11	8.7			1.2				1.0	10.7			23.9	9.4	35
	12	8.9			.6				1.8	7.9			18.2	6.7	30
	13	8.1			1.5				.5	2.9			17.3	7.8	24
A	14	8.1			1.4				.5	8.4			23.0	11.7	33
	15	8.6			1.0				.8	9.8			26.0	9.9	31
	16	8.7			.9				1.2	5.3			25.4	11.8	32

Soil		CATION EXCHANGE CAPACITY	Extractable CATIONS Ca	Mg	Na	K	Available P ppm	SATURATION EXTRACT SOLUBLE Na	K	CO_3	HCO_3	Cl	SO_4	PERCENT MOISTURE AT SATURATION	Plastic Index %
		←	NH_4OAc me/100g				→	←	milliequivalents per liter				→		
As	9			.4	.4	.3	6.9							38	NP
	10			1.0	1.3	.1	1.6							52	NP
	11			1.6	7.2	.1	1.1							51	NP
	12			1.6	8.4	.1	.8							40	NP
	13			1.0	.5	.3	7.5							32	NP
A	14			1.1	1.1	.2	2.1							47	3
	15			.6	4.6	.1	1.1							44	3
	16			.6	10.4	.2	2.8							48	4

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	LABORATORY NUMBER	COLLECTOR'S NUMBER	DEPTH cm.	HORIZON	PARTICLE SIZE DISTRIBUTION (in mm) (percent) VERY COARSE SAND 2-1	COARSE SAND 1-0.5	MEDIUM SAND 0.5-0.25	FINE SAND 0.25-0.10	VERY FINE SAND 0.10-0.05	% SILT – Hydrometer	% CLAY – Hydrometer	% Sand – Hydrometer	% > 2 mm	TEXTURAL CLASS
Soil														
	17	#75	0-10		7	1	1	1	2	62	23	15	0	SiL
W	18		10-20		<1	1	1	5	9	60	17	23	0	SiL
	19		20-30		1	1	<1	1	2	59	38	3	0	SiCL
	20		30-65		<1	<1	<1	1	2	64	34	2	0	SiCL
	21		65-90		<1	<1	1	40	31	17	8	75	0	SL
	22		90-130		<1	<1	<1	29	37	23	8	69	0	SL
	23		130-195		1	1	<1	2	4	68	17	15	0	SiL

	LABORATORY NUMBER	pH SATURATED PASTE	pH 1:5	ORGANIC MATTER	ORGANIC CARBON %	NITROGEN %	C/N	TOTAL SOLUBLE SALTS %	ELECTRICAL CONDUCTIVITY EC x 10^3 MILLIMHOS PER CM @ 25°C	$CaCO_3$ equivalent per cent	GYPSUM me./100g SOIL	GYPSUM %	MOISTURE TENSIONS 1/3 ATMOS. %	MOISTURE TENSIONS 15 ATMOS. %	Liquid Limit %
Soil															
	17	8.2			5.1				1.4	11.3			34.3	14.7	47
W	18	8.2			1.1				1.5	11.0			22.2	8.4	26
	19	8.0			1.2				14.0	12.0			32.0	15.4	39
	20	8.1			1.0				24.0	11.4		1	30.9	12.6	33
	21	8.2			.3				16.0	6.0			7.7	3.8	*
	22	8.3			.5				16.0	7.1			9.8	4.1	*
	23	8.1			.8				28.0	12.3			31.0	9.3	31

*Too Sandy

	LABORATORY NUMBER	CATION EXCHANGE CAPACITY	Extractable CATIONS Ca	Mg	Na	K	Avail P ppm	SATURATION EXTRACT SOLUBLE Na	K	CO_3	HCO_3	Cl	SO_4	PERCENT MOISTURE AT SATURATION	Plastic Index %
Soil		NH_4OAc me/100g						milliequivalents per liter							
	17			5.5	1.3	2.7	27							67	8
W	18			4.0	1.6	1.7	2.1							47	2
	19			8.9	7.8	1.5	2.0							65	16
	20			11.5	13.3	.7	2.0							60	12
	21			4.5	4.6	.2	1.2							33	*
	22			5.8	5.7	.1	.7							34	*
	23			10.0	13.3	.3	.7							51	6

*Too Sandy

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Soil	Laboratory Number	Collector's Number	Depth in cm.	Horizon	Particle Size Distribution (in mm.) (percent): Very Coarse Sand 2-1	Coarse Sand 1-0.5	Medium Sand 0.5-0.25	Fine Sand 0.25-0.10	Very Fine Sand 0.10-0.05	% Silt (Hydrometer)	% Clay (Hydrometer)	% Sand (Hydrometer)	% > 2 mm.	Textural Class
E	24	#76	0-10		2	2	3	15	32	31	8	61	2	SL
	25		10-23		1	1	2	9	23	41	16	43	1	L
	26		23-47		1	1	1	6	24	45	23	32	0	L
	27		47-75		3	3	6	20	17	33	19	48	3	L
	28		75-120		4	6	8	22	14	29	14	57	14	SL
	29		120-150		8	8	9	22	13	25	14	61	26	SL

Soil	Laboratory Number	pH: Saturated Paste	pH: 1:5	Organic Matter: Organic Matter %	Organic Carbon %	Nitrogen %	C/N	Total Soluble Salts %	Electrical Conductivity EC x 10³ Millimhos per cm @25°C	CaCO3 equivalent per cent	Gypsum: me./100g soil	Gypsum %	Moisture Tensions: 1/3 Atmos. %	15 Atmos. %	Liquid Limit %
E	24	8.2			.6				.5	5.2			11.8	5.0	20
	25	8.2			.5				.7	12.5			17.3	7.1	22
	26	8.4			.4				.7	13.7			23.0	9.4	27
	27	8.6			.3				.9	11.9			21.6	8.6	23
	28	8.1			.4				4.2	9.4			16.8	6.9	23
	29	8.0			.4				18.0	7.8			16.1	6.4	22

Soil	Laboratory Number	Extractable Cations: Cation Exchange Capacity	Ca	Mg	Na	K	Available P ppm	Saturation Extract Soluble: Na	K	CO_3	HCO_3	Cl	SO_4	Per Cent Moisture at Saturation	Plasticity Index %
		← NH_4OAc me/100g →						← milliequivalents per liter →							
E	24			1.5	.3	.4	7.9							31	NP
	25			2.6	.6	.2	1.3							33	NP
	26			3.3	1.7	.2	.8							37	8
	27			2.4	3.5	.2	.7							31	1
	28			1.7	5.2	.1	1.0							34	NP
	29			1.7	10.1	.2	1.4							30	NP

APPENDIX V-2

Infiltration Rates During Various Time Intervals (minutes) By Plot Measured in Inches per Hour

Map Unit	Plot #	3-8	8-13	13-18	18-23	23-28	CN	Sediment Yield	% Bare Soil
				D_S Soil (Wet)					
D_SB	1	2.7	2.9	2.7	2.4	2.5	90	0.25	28
D_SB	2	3.4	3.2	3.0	2.8	2.6	95	0.20	"
D_SB	3	2.9	2.8	3.1	2.7	2.9	82	0.03	"
D_SB	7	1.9	1.5	1.8	1.4	1.5	94	0.38	16
D_SB	8	1.6	1.7	1.6	1.5	1.4	95	0.79	"
D_SB	9	1.9	1.5	1.3	1.5	1.1	93	0.33	"
D_SB	10	1.5	1.3	1.4	1.4	1.5	94	0.32	21
D_SB	11	1.4	1.3	1.7	1.5	1.4	95	0.67	"
D_SB	12	2.1	2.0	2.2	2.1	2.3	92	0.78	"
D_SB	13	2.8	2.2	2.7	2.3	1.9	90	0.34	19
D_SB	14	3.1	3.1	3.0	3.1	2.7	85	0.25	"
D_SB	15	2.5	2.4	2.2	2.1	2.1	90	0.28	"
D_SB	16	3.1	2.9	2.8	2.4	2.6	81	0.01	30
D_SB	17	4.1	3.4	3.4	3.4	2.9	62	0.00	"
D_SB	18	3.4	2.7	2.8	2.4	2.0	67	0.00	"
D_SB	19	3.5	4.1	2.9	2.7	2.7	80	0.09	65
D_SB	20	3.9	4.1	3.2	3.7	3.5	80	0.17	"
D_SB	21	2.8	2.8	2.0	2.1	2.2	77	0.28	"
				B_S Soil (Wet)					
B_SB	25	0.8	0.6	0.8	0.6	0.7	92	0.69	39
B_SB	26	2.3	0.8	1.0	0.7	0.7	90	0.80	"
B_SB	27	1.7	0.8	1.0	0.6	0.7	96	0.57	"
B_SC	22	1.6	1.0	1.1	1.4	1.0	95	0.86	60
B_SC	23	1.8	1.4	1.5	1.5	1.5	89	0.59	"
B_SC	24	2.1	2.2	2.1	1.9	1.7	88	0.23	"
B_SC	61	1.9	1.3	1.1	0.9	0.9	93	0.12	36
B_SC	62	1.4	1.3	1.0	1.0	1.1	95	0.12	"
B_SC	63	1.8	1.9	1.1	1.1	1.5	93	0.09	"
B_SC	64	2.8	1.1	1.0	1.3	1.7	93	0.21	"
B_SC	65	1.9	1.1	1.4	1.0	1.0	91	0.32	"
B_SC	66	1.7	1.1	1.0	1.3	1.1	94	0.07	"
B_SD	4	2.5	2.4	2.1	2.4	2.3	88	0.42	12
B_SD	5	1.5	1.3	1.5	1.9	1.2	95	2.40	"
B_SD	6	2.0	1.6	1.8	2.0	1.9	91	0.42	"
B_SD	43	1.8	1.6	1.2	1.2	1.6	92	0.15	36
B_SD	44	1.1	0.9	1.1	1.1	1.7	94	----	"
B_SD	45	1.0	1.1	0.5	0.7	0.5	96	0.11	"

Liquid Limit %	Plasticity Index %
20	NP
22	NP
27	8
23	1
23	NP
22	NP

Infiltration Rates During Various Time Intervals (minutes) By Plot Measured in Inches per Hour

Map Unit	Plot #	3-8	8-13	13-18	18-23	23-28	CN	Sediment Yield	% Bare Soil
B_SD	28	3.7	3.1	3.7	3.4	2.6	86	0.59	43
B_SD	29	2.2	2.1	2.4	1.8	1.8	92	4.72	"
B_SD	30	4.0	2.0	2.5	2.0	1.7	88	2.02	"
B_SE	55	1.6	1.1	1.1	1.3	1.2	93	0.09	42
B_SE	56	1.2	0.7	0.8	0.7	0.8	96	0.21	"
B_SE	57	1.2	0.6	0.6	0.5	0.5	94	0.21	"
B_SE	59	2.6	2.3	2.6	1.8	1.9	86	0.12	"
B_SE	60	1.2	0.8	0.9	0.9	1.4	94	0.15	"
				A Soil (Wet)					
AB	49	1.5	1.5	1.1	1.4	1.3	92	0.04	18
AB	50	1.5	1.2	1.0	1.2	1.0	94	0.05	"
AB	51	1.6	1.1	1.1	1.1	1.1	97	0.05	"
AC	46	0.9	0.9	0.9	1.1	1.2	96	0.06	46
AC	47	1.7	1.7	1.9	1.9	2.0	92	0.12	"
AC	48	1.2	1.1	1.1	1.1	1.1	95	0.06	"
AD	34	2.3	2.2	1.9	1.8	1.7	91	0.26	9
AD	35	1.5	1.1	1.1	1.0	0.9	96	1.14	"
AD	36	1.8	1.5	1.2	1.1	1.0	95	0.43	"
AD	52	1.1	0.6	0.8	0.7	0.6	97	0.11	33
AD	53	0.6	1.9	0.6	0.6	0.5	96	0.13	"
AD	54	1.4	1.5	1.2	1.3	1.3	92	0.06	"
				A_S Soil (Wet)					
A_SC	85	1.5	1.1	1.0	2.5	0.9	93	0.07	35
A_SC	86	1.2	1.7	1.6	2.4	1.2	94	0.05	"
A_SC	87	0.7	0.5	0.7	0.8	0.5	97	0.07	"
A_SC	88	0.6	0	0.9	0.9	0.4	96	0.17	"
A_SC	89	0.8	0.6	0.7	0.6	0.9	97	0.21	"
A_SC	90	1.2	1.3	0.7	0.7	1.2	96	0.07	"
				W Soil (Wet)					
W	37	0.8	0.6	0.5	0.6	0.6	97	0.09	48
W	38	0.9	0.3	0	0	0	98	0.18	"
W	39	0.7	0.8	0.8	0.6	0.6	97	0.11	"
W	40	1.6	0.7	0.8	0.7	0.8	94	0.05	"
W	41	0.4	0	0.5	0	0.9	98	0.07	"
W	42	2.2	0.9	1.0	0.5	0.5	96	0.04	"

Infiltration Rates During Various Time Intervals (minutes) By Plot Measured in Inches per Hour

Bare Soil	Map Unit	Plot #	3-8	8-13	13-18	18-23	23-28	CN	Sediment Yield	% Bare Soil
					N Soil (Wet)					
43	NB	73	0.4	0.1	0.1	0.3	0.1	98	0.07	100
"	NB	79	0	0	0	0.1	0	100	0.10	"
"	NB	75	0.3	0.2	0.2	0.3	0.4	98	0.09	"
42	NB	76	0	0	0.1	0	0	100	0.10	"
"	NB	77	0.5	0.9	0.4	0.5	0.5	97	0.29	"
"	NB	78	0.9	0.9	0.7	0.7	0.3	98	0.38	"
"										
					F Soil (Wet)					
	F	79	2.1	2.0	1.3	1.7	1.6	91	0.06	44
	F	80	1.5	1.6	1.6	1.3	1.4	94	0.04	"
18	F	81	2.5	2.4	2.3	2.4	2.5	84	0.07	"
"	F	82	2.8	2.4	2.4	2.4	2.2	84	0.04	"
"	F	83	1.7	1.6	1.5	1.3	1.2	93	0.05	"
46	F	89	2.5	2.0	1.7	1.9	1.6	89	0.06	"
"										
					E Soil (Wet)					
9										
"	EB	67	3.0	3.5	1.5	1.5	1.5	86	0.02	"
"	EB	68	3.7	2.2	2.2	1.9	1.8	86	0.03	"
33	EB	69	2.8	1.9	2.0	1.7	1.9	85	0.03	"
"	EB	70	1.2	1.3	0.7	1.1	0.9	96	0.08	"
"	EB	71	2.3	2.3	1.9	1.7	1.7	90	0.09	"
	EB	72	1.1	0.8	1.2	0.9	1.1	96	0.05	"
					B Soil (Wet)					
35										
"	BB	97	0.6	0.4	0.6	0.5	0.6	97	0.07	23
"	BB	98	0.7	0.5	0.6	0.5	0.6	98	0.07	"
"	BB	99	0.6	0.2	0.1	0	0	99	0.08	"
"	BB	100	1.6	0.8	0.5	0.6	0.6	96	0.05	"
	BB	101	1.9	0.9	0.9	0.9	0.9	94	0.03	"
	BB	102	0.9	0.8	0.7	0.7	1.2	97	0.05	"
	BD	91	1.1	0.6	0.7	0.4	0.4	97	0.08	19
	BD	92	1.4	1.4	1.3	1.3	1.1	95	0.03	"
48	BD	93	1.5	1.5	1.4	1.3	0.9	93	0.03	"
"	BD	94	0.6	0.6	0.5	0.7	0.6	97	0.20	"
"	BD	95	0.7	0.8	0.6	0.6	0.5	98	0.09	"
"	BD	96	1.1	0.8	0.7	0.6	0.8	96	0.12	"
"										

Infiltration Rates During Various Time Intervals (minutes) By Plot Measured in Inches per Hour

Map Unit	Plot #	3-8	8-13	13-18	18-23	23-28	CN	Sediment Yield	% Bare Soil
				D Soil (Dry)					
D	1	3.0	3.2	2.6	2.7	2.2	92	0.20	28
D	2	3.4	3.2	3.0	2.8	2.6	87	0.15	"
D	3	3.9	2.8	3.0	2.9	3.3	77	0.01	"
D	7	2.7	1.8	2.2	1.6	1.5	94	0.18	16
D	8	2.5	1.9	1.7	1.5	1.4	94	0.27	"
	9	3.0	2.0	1.5	1.3	1.2	91	0.16	"
				B_s Soil (Dry)					
B_sD	4	3.0	2.9	3.0	3.0	2.4	87	0.22	12
B_sD	5	3.6	3.4	2.8	2.6	2.5	86	0.47	"
B_sD	6	3.5	2.7	3.3	1.8	2.1	86	0.68	"

APPENDIX V-3

ALBUQUERQUE LABORATORY

REPORT OF ANALYSIS

CUSTOMER AEROVIRONMENT INC.
ATTENTION Dr. Ivar Tombach, Director of Environmental Programs
ADDRESS 145 Vista Avenue
CITY Pasadena, California 91107
S.O. NO. 3050

TYPE OF ANALYSIS DETERMINATION of RADIUM-226 & STRONTIUM-90 in SOIL SAMPLES
CUSTOMER ORDER NUMBER 45327
SAMPLES RECEIVED 12-19-74

Sample Identification	Total Dry Weight (g)	pCi/g (Dry) Ra-226	pCi/g (Dry) Sr-90
#39 0-4	2728	0.17 ± 0.01	0.52 ± 0.02
#39 17-35	2545	0.66 ± 0.03	0.00 ± 0.01
#40 0-6	2542	0.87 ± 0.03	0.48 ± 0.02
#40 31-137	2959	0.66 ± 0.03	0.02 ± 0.01

cc: Dr. Stephan Friedland

☐ REPORTED VIA TELEPHONE
☐ REPORTED VIA TWX

PAGE 1 OF 1 PAGE

EBERLINE INSTRUMENT CORPORATION
P.O. BOX 3874 ALBUQUERQUE, NEW MEXICO 87110
PHONE (505) 345 3461 TWX: 910-985-0678

APPROVED BY Ernest A. Sanchez
Ernest A. Sanchez, Manager
Albuquerque Laboratory

03-13-75 DATE

APPENDIX V-3

ALBUQUERQUE LABORATORY

CUSTOMER AEROVIRONMENT INC.
ATTENTION Dr. Ivar Tombach, Director of Environmental Programs
ADDRESS 145 Vista Avenue
CITY Pasadena, California 91107
S.O. NO. 3051

REPORT OF ANALYSIS

DETERMINATION of GAMMA ISOTOPIC 45327
TYPE OF ANALYSIS by GeLi in SOIL SAMPLES CUSTOMER ORDER NUMBER SAMPLES RECEIVED 12-19-74

Identification:	#39 0-4	#39 17-35	#40 0-6	#40 31-137
Dry Weight (g):	2728	2546	2542	2960

Nuclide Observed	pCi/g (Dry)			
K-40	18 ± 2	11 ± 3	20 ± 3	16 ± 2
Bi-214	0.73 ± 0.29	0.49 ± 0.29	0.79 ± 0.36	0.85 ± 0.31
Tl-208	0.36 ± 0.11	0.19 ± 0.11	0.30 ± 0.12	0.30 ± 0.12
Pb-214	0.65 ± 0.27	0.71 ± 0.24	0.78 ± 0.30	0.74 ± 0.27
Ac-228	0.92 ± 0.52	0.79 ± 0.50	< 0.68	0.94 ± 0.50
Pb-212	1.5 ± 0.3	1.2 ± 0.3	1.0 ± 0.3	1.0 ± 0.3
Cs-137	0.98 ± 0.14	< 0.12	1.6 ± 0.2	0.09 ± 0.08

cc: Dr. Stephan Friedland

☐ REPORTED VIA TELEPHONE
☐ REPORTED VIA TWX

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APPROVED BY Ernest A. Sanchez, Manager
Albuquerque Laboratory

03-13-75
DATE

APPENDIX V-4

EXTRACTABLE ALUMINA IN SPENT SHALE
P AND X HOLES

Footage Interval	Percent Alumina					
	P-1	P-2	P-3	P-4	X-1	X-2
450-460	-	-	-	0.174	-	-
460-470	-	-	-	0.574	-	-
470-480	-	-	-	1.160	-	-
480-490	-	-	-	0.300	-	-
490-500	0.320	-	-	0.921	-	-
500-510	0.317	-	-	0.260	-	-
510-520	0.453	-	-	0.220	-	0.166
520-530	0.598	-	-	0.779	-	0.203
530-540	0.208	-	-	0.901	-	0.221
540-550	0.260	-	0.124	0.800	-	0.137
550-560	0.265	-	0.098	1.196	-	0.143
560-570	0.193	-	0.161	0.886	-	0.934
570-580	0.238	0.141	0.125	0.761	-	0.134
580-590	0.008	0.143	0.147	0.822	-	0.222
590-600	0.265	0.141	0.164	0.262	-	0.120
600-610	0.240	0.141	0.086	0.914	-	0.103
610-620	0.227	0.073	0.114	0.804	-	0.169
620-630	0.171	0.098	0.264	0.902	-	0.259
630-640	0.835	0.146	-	1.445	-	0.184
640-650	0.198	0.188	0.755	0.241	-	0.226
650-660	0.214	0.214	0.609	0.195	-	0.124
660-670	0.192	0.263	0.283	0.162	-	0.098
670-680	1.500	0.173	0.252	0.107	-	0.087
680-690	0.118	0.193	0.292	0.856	-	0.076
690-700	0.062	0.148	0.894	0.722	-	0.112
700-710	0.063	0.212	0.187	0.516	-	0.177
710-720	0.054	0.154	0.135	0.179	-	0.214
720-730	0.201	0.146	0.782	0.093	-	0.702
730-740	0.201	0.157	0.166	0.290	-	0.368
740-750	0.233	0.200	0.227	0.280	-	1.017
750-760	0.164	0.093	0.152	0.260	-	1.121
760-770	0.173	0.101	0.176	1.057	-	-
770-780	0.070	0.090	0.685	0.816	-	-
780-790	0.086	0.101	0.253	1.320	-	-
790-800	0.132	0.081	0.180	1.190	-	-
800-810	0.230	0.170	0.217	0.792	-	-
810-820	0.598	0.140	0.124	0.562	-	-
820-830	0.978	0.137	0.493	1.420	-	-
830-840	0.874	0.080	0.117	0.973	-	-
840-850	1.449	0.064	0.166	1.220	-	-
850-860	1.120	0.070	0.998	0.870	-	-
860-870	0.938	0.081	0.906	1.870	-	-

APPENDIX V-4 (Cont.)

Footage Interval	Percent Alumina P-1	P-2	P-3	P-4	X-1	X-2
870-880	0.496	0.085	0.800	2.070	0.674	-
880-890	0.552	0.070	1.406	1.640	0.240	-
890-900	0.757	0.095	1.114	3.000	0.223	-
900-910	0.586	0.655	0.787	2.280	0.174	-
910-920	0.859	0.100	0.991	2.050	0.180	-
920-930	1.210	0.177	1.053	1.317	0.209	-
930-940	1.312	0.161	0.227	2.112	0.305	-
940-950	1.393	0.208	1.264	2.253	0.263	-
950-960	2.058	0.163	1.414	1.763	0.431	-
960-970	1.447	0.120	1.592	2.572	0.378	-
970-980	1.175	0.076	1.468	2.700	0.247	-
980-990	1.274	0.234	2.357	2.949	0.548	-
990-1000	1.918	0.269	2.591	1.480	0.402	-
1000-1010	1.931	0.068	1.944	1.300	0.193	-
1010-1020	2.079	1.021	1.570	1.830	0.292	-
1020-1030	2.179	2.336	2.264	1.120	0.253	-
1030-1040	2.254	2.625	2.862	0.980	0.211	-
1040-1050	-	*	2.783	1.574	0.264	-
1050-1060	-	*	2.070	1.730	0.292	-
1060-1070	-	1.330	2.340	1.315	0.291	-
1070-1080	-	2.113	3.016	1.863	0.576	-
1080-1090	-	0.245	2.657	2.250	0.620	-
1090-1100	-	0.205	2.025	1.580	0.241	-
1100-1110	0.838	2.049	1.060	2.700	0.172	-
1110-1120	1.182	2.063	0.907	3.300	0.523	-
1120-1130	1.643	2.326	1.378	0.682	0.320	-
1130-1140	1.190	2.625	0.735	1.191	-	-
1140-1150	0.852	2.480	0.866	3.000	-	-
1150-1160	1.319	0.094	2.268	2.635	-	-
1160-1170	1.529	0.097	1.754	3.300	-	-
1170-1180	1.200	1.134	1.411	-	-	-
1180-1190	2.120	0.991	1.613	-	-	-
1190-1200	1.635	0.296	1.984	-	-	-
1200-1210	1.345	0.738	1.941	-	-	-
1210-1220	0.200	2.190	2.672	-	-	-
1220-1230	-	1.416	-	-	-	-
1230-1240	-	1.223	-	-	-	-
1240-1250	-	1.254	-	-	-	-
1250-1260	-	1.553	-	-	-	-
1260-1270	-	1.406	-	-	-	-
1270-1280	-	0.241	-	-	-	-
1280-1290	-	1.769	-	-	-	-

*Lost Core.

EXHIBIT B

Construction activities to be started prior to September 1, 1982

- o Mine access road to mine site (5 acres)
- o Grade construction camp (1 acre)
- o General earthwork (50 acres)
  - Mine construction road
  - Production well access road
  - Substation and generator building
  - Sewage treatment plant
  - Treated effluent holding pond
  - Service building area
  - Water treatment plant and storage facilities
  - Construction topsoil stockpile area
  - Decline portal
  - Concrete batch plant
  - Parking area
  - Change house and office building
  - Service shaft
  - Air intake shaft
- o Mine Services Building
  - Mobilize
  - Temporary Power
  - Concrete Batch Plant
  - Start Foundation